INDONESIA AUSTRALIA
RED MEAT & CATTLE PARTNERSHIP

Australian Government

BKPM
BADAN KOORDINASI PENANAMAN MODAL

COMMERCIAL CATTLE BREEDING MANUAL

IACCB
Indonesia-Australia Commercial Cattle Breeding Program

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IACCB, which commenced in February 2016, is a project within the Indonesia-Australia Partnership on Food Security in Red Meat and Cattle Sector.

IACCB's goal is to expand the commercial-scale beef cattle breeding industry in Indonesia. It does this by partnering with private sector project partners (farmer groups, farmer cooperatives and plantations) to test three cattle breeding models (1) Integrated Oil Palm and Cattle Production; (2) Open-Grazing and (3) Smallholder Cut-and-Carry.

The Indonesian partners run the pilots with IACCB providing technical support from internationally and Indonesian recognized specialists in herd management, tropical herd nutrition, tropical pasture and feed supply development, animal health and animal welfare and farm practices.

Much of the management with Integrated Oil Palm and Cattle Production (SISKA) has gradually developed as the project proceeded because there was little detailed information available, especially when introducing heifers and young bulls from Australia.

IACCB has documented the experiences in a manual consisting of four technical modules to assist managers and investors start and manage commercial cattle breeding in Indonesia. The modules include:

- Economics of Commercial Cattle Breeding
- Cattle Breeding Herd Management
- Pastures and Pasture Development
- Monitoring and Evaluation of a Cattle Breeding Enterprise.

This manual provides a guide to many aspects of enterprise, herd and pasture management. This internet verson is interactive in that readers can select sections relevant to their particular interest or operation.

The sections listed below can be brought up by clicking the the section heading.

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1.1. The beef cattle breeding business

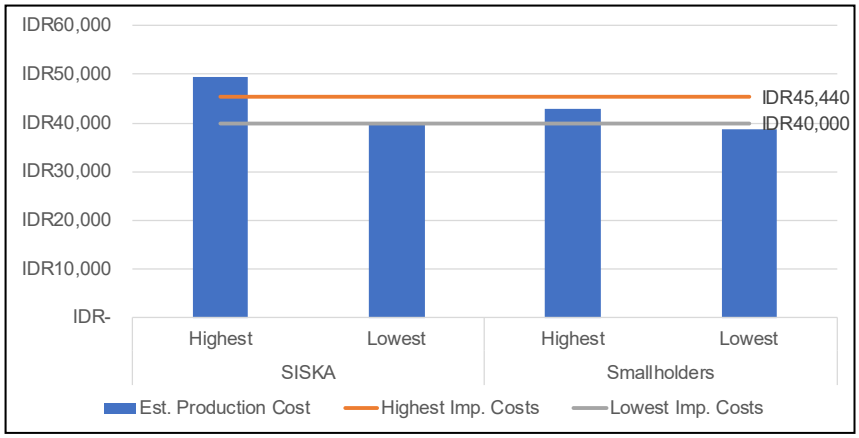
While a commercial cattle breeding enterprise is feasible in Indonesia, it is more complex than a beef feedlot operation, particularly in relation to cash flow. Feedlots generate income every 90 to 120 days when feeder cattle have been fattened and are sold. Cattle breeding operations have a lag phase of at least one year, more commonly three, to produce a calf and then a market-ready product before income is generated. Breeding operations are a long-term investment.

Producing a calf in Indonesia is more expensive than in northern Australia. Thus the calf has to be grown out to at least the feeder stage to generate a profitable return. A three-month old weaner calf in Indonesia will generally take 14 to 24 months to reach a liveweight of 320kg. However, fattening feeder cattle can usually be done more cheaply in Indonesia because the by-products used as cattle feed are relatively low-cost. Even with the added cost of transportation, associated importation fees and seller's profit, the cost of an imported feeder is still on par with the production cost of local feeders from efficient operations.

Indonesian breeding operations rely on their ability to manage the costs of producing a feeder animal to achieve a saving over the cost of importing a feeder animal from Australia.

Figure 1. shows the total costs of producing feeder cattle in Indonesia using SISKA – cattle grazed under oil palms – and smallholder systems. The best of the SISKA systems and the smallholder systems were able to match the cost of imported feeder cattle landed in West Java or South Sumatra. Note that these projects are still in their infancy and much room for improvement remains. Costs of Gain of the feeder cattle could be significantly lower should all KPIs be met or improved upon.

Figure 1: Costs of production for locally produced feeder cattle vs. cost of imported feeders (May 2019)



This section provides information on the economics of establishing a cattle breeding enterprise in Indonesia. It considers the following factors:

- Choosing the production and partnership model
- Key factors that impact financial performance
  - Land location and suitability
  - A quality breeding herd – buying heifers and bulls
  - Infrastructure requirements matched to the enterprise
  - Labour and human resources
  - Feeds – by-products, concentrates, forages and pastures
  - The cost of liveweight gain
  - Markets for all classes of cattle.
- Key performance indicators – measurements to track progress and profitability
- The business cycle: Start-up; expansion; and business maturity
- Cash flow, payback period and Internal Rate of Return (IRR)
- An Excel-based spreadsheet to assist with decision-making - CALFIN.

1.2. Choosing the production and partnership model

Cattle grazing under oil palms

Cattle grazing open pasture

Cattle in breedlots

1.2.1. Production models

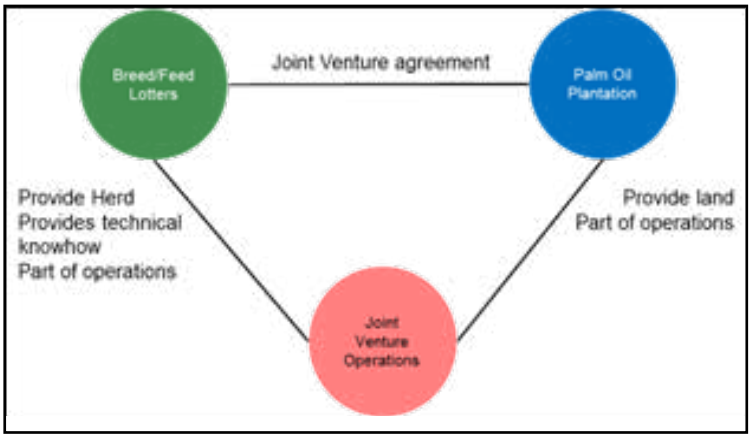
There are several potential models for cattle breeding that are possible in Indonesia. These include:

- ***SISKA*** – the cattle-oil palm integrated system (normally referred to as SISKA) in which cattle graze on large areas of low-cost land under palms. This under-story grazing resource is provided at no cost to the cattle operation. Additional concentrate feeds are needed for lactating and recovering cows as the under-story pastures are of poor quality. Areas of open improved pastures can also be developed to augment the under-story pastures;
- ***Open grazing systems*** – where cattle graze open native or improved pastures. Cattle may permanently graze in the fields or they may graze during the day but return to a barn at night. By-products and other rations can be fed to the cattle permanently in the field or when the cattle are in the barn.
- ***Cut-and-carry (small-scale farmers) and breedlots (large scale)*** – where cattle are permanently kept in yards and fed forages and concentrate rations. This system is used where grazing land is not available. Large-scale breedlots often exist as a unit within a feedlot
- ***Combinations of the above –*** depending on factors such as weather, feed, cattle condition a combination of all and any of the above may be used. For example, weaners and dry cattle could be grazed in a plantation with breeders remaining in yards to reduce calf mortality in times of heavy rain. Some smallholder farmers are able to graze their weaners while the cows remain in their pens.

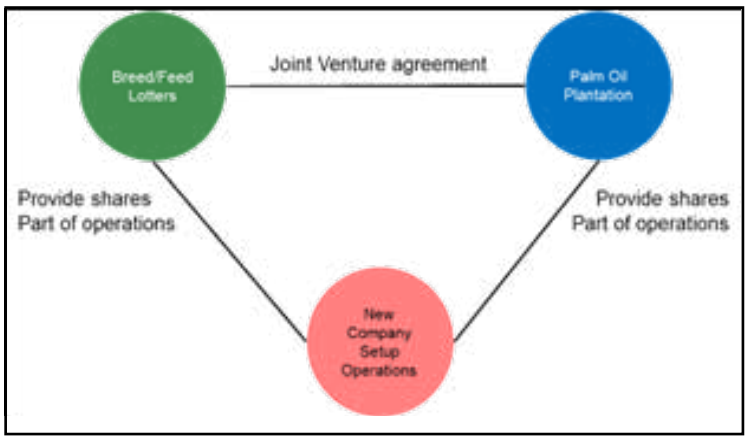
1.2.2. Partnership models

There are several options for cattle companies interested in investing in SISKA systems in partnership with plantation owners. These include (a) agreements between the cattle company and oil palm company through either a memorandum of understanding or a joint venture arrangement and (b) the development of a business unit within an oil palm company where no additional company is involved. Similar arrangements could potentially be made between feedlot companies and companies or smallholder cooperatives managing breeding operations. These partnership models are described below.

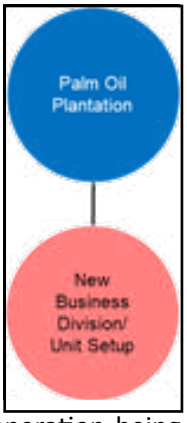
- ***Memorandum of Understanding*** (MoU). Legal arrangements between oil palm plantations and cattle sector investors are commonly arranged via MoUs in which the operational and investment costs are contributed by each partner and operational arrangements are specified in the MoU (below);



- ***Joint venture company***. A new proprietary limited company can be established between an oil palm company and a cattle breeding company. The new company would clarify the financial and operational arrangements guiding the joint venture (below);



- ***Business division / unit***. A new business division or unit can be established within an oil palm company as a component of the company's business diversification (right). The company may recruit a specialised manager to supervise the cattle business division / unit or alternatively appoint an existing manager to supervise skilled operational staff that have been recruited for the task.



The same options would be applicable to a breeding operation being established in cooperation with a feedlot company or to a breedlot or feedlot wanting to integrate smallholder farmers into some aspect of the production cycle.

Partnership models

The best partnership model will align with the technical, financial an management capacity of the cattle enterprise, as well as its business aspirations and attitude to risk.

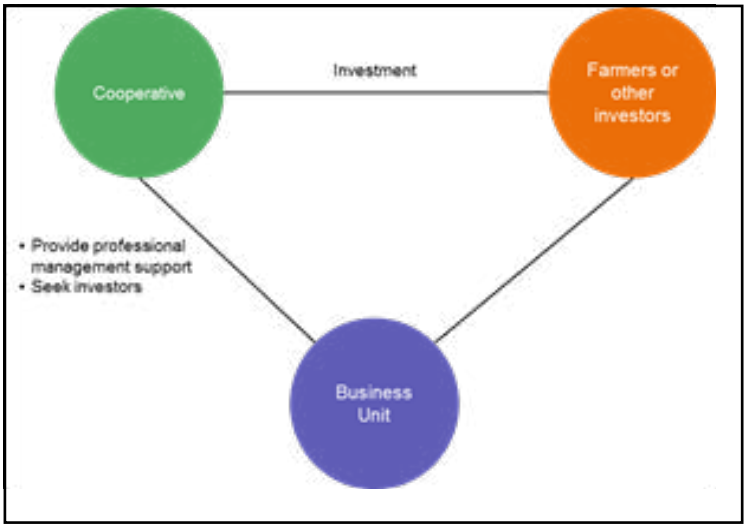
Each model does not directly confer a particular level of business performance potential. All models can be successful given the right foundations in terms of:

- an appropriate financial basis
- implementation of effective herd management systems
- effective integration between the business units – cattle / oil palm in SISKA or fattening / breeding in intensive system and
- committed and capable human resources

1.2. Choosing the production and partnership model

Smallholders also have options for formalising their cattle breeding enterprises. Having a formal business status often makes it easier to access finance and achieve efficiencies of scale in purchasing and marketing. These include:

- ***Limited company***. A small to medium enterprise, owned by farmers, may be registered formally;
- ***Livestock cooperative****, where livestock production is pooled and members farm jointly;*
- ***Business unit of cooperative***. A commercial business division / unit can be established as part of an existing cooperative. The business division / unit may hire professionals to run the business or appoint an existing manager to supervise skilled operational staff that have been recruited for the task *(see below)*.



1.3. Key factors affecting financial performance

1.3. Key factors affecting financial performance

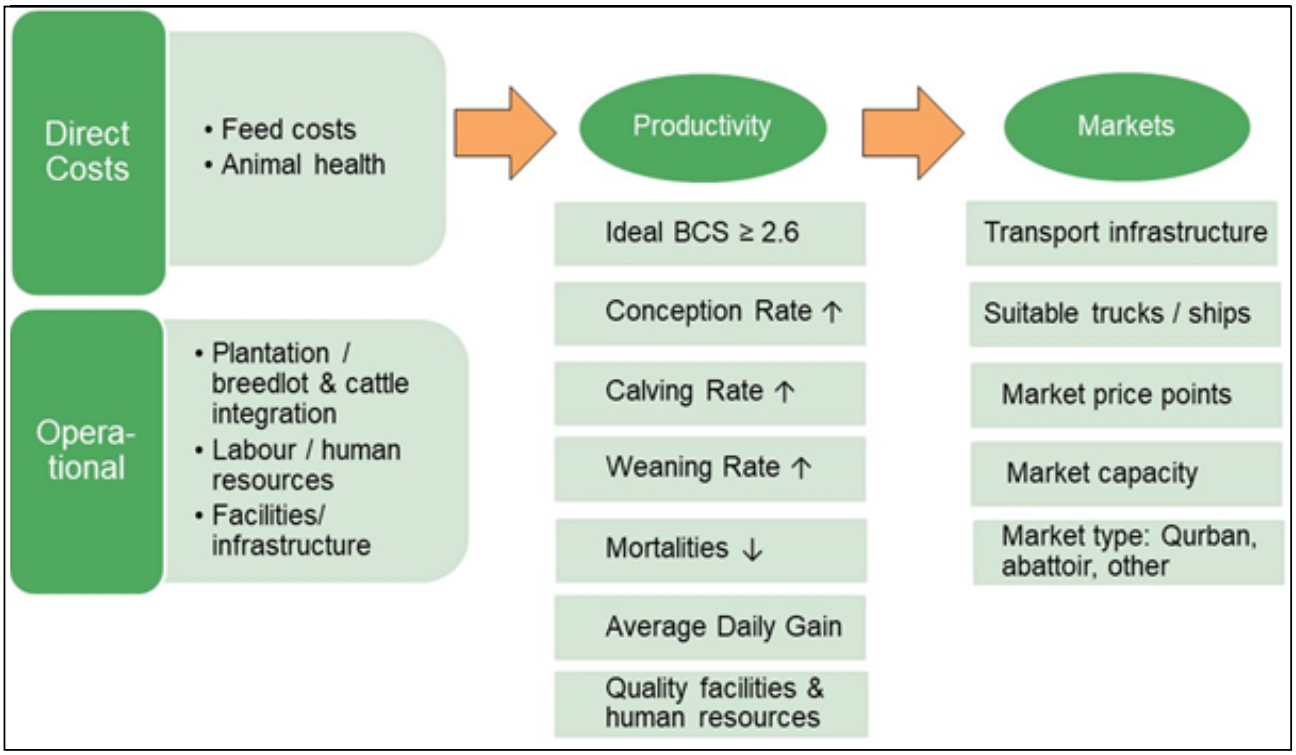
1.3.1. Introduction

Key factors that impact financial performance include:

- Operational costs, including facilities for cattle management and welfare; skilled human resources and a high level of integration between the cattle and oil palm / feedlot components of the enterprise:
- Direct costs, including the cost of feed and pasture development and animal health inputs.

These operational and direct cost inputs affect a range of productivity and performance factors such as BCS, conception rate, calving rate, weaning rates, calf and cow mortality and liveweight gain (see figure below). High logistics costs will play a role when the farm is isolated from cost effective transport but the land will be cheaper. Critically, the right level of inputs - land, labour, infrastructure, feed, etc. - must be sought to achieve the desired outputs - revenue from sale of cattle and related products.

These factors are examined in further detail in other parts of this manual.



1.3.2. Land requirements

The great benefit of working in partnership with an oil palm plantation (SISKA) is that there is no land cost involved for the cattle joint venture or division/unit. The land is generally one of the contributions of the plantation partner.

Breedlots and smallholder cut-and-carry systems will also normally have land available to house cattle, although this will rarely include land for free grazing and may include only limited land area for production of cut-and-carry forages.

Semi-intensive and extensive models will generally require land to be purchased specifically for the cattle enterprise. Considerations for land requirements are provided in the table below.

More information on land, including typical stocking rates, is provided in Section 10: Land and infrastructure.

Getting started in SISKA

The average SISKA operation would commence with 300 breeders and 20 bulls. Given a plantation with palm blocks of various age, a minimum of 2,000 ha of oil palm understory area would be required for grazing. In addition, at least 30 ha of open, improved pasture should be developed to support cows close to calving or post-calving and to provide high protein quality fodder for the weaners.

1.3.3. Key factors

Whichever production model is used, the following key factors will need to be considered before commencing a breeding program. These are:

- ***Competency of management and staff.*** Livestock require the right care and attention if they are to be productive and their outputs optimised. Experienced management and staff will potentially achieve this. Conversely, a lack of experience increases the likelihood of failure.
- ***Location.*** The efficient production of cattle for the market is a significant challenge to overcome but achievements can be undone through a lack of access to resources and markets. Location of your enterprise will largely determine your marketing options (destinations) and associated costs. Breeding cattle outside of Java and Sumatra may reduce input costs, but it will limit marketing opportunities.
- ***Availability of forages and other sources of feed***. A mature cow of 400kg will consume 40–50kg of fresh forage per day. Low cost feeds of at least moderate quality are necessary to drive a profitable cattle breeding business. Generally the cheapest feeds are grass pastures, however these exist only where land is available at low cost. Low-cost agricultural by-products can also form the basis of feed rations.
- ***Availability of water***. Mature cattle will each consume up to 40 litres of water per day. Water should be easily accessible from either water troughs or from creeks and gullies. Water should be tested for quality as pollutants from upstream are not uncommon in Indonesia. Water availability is especially important during the dry season when the high temperatures increase requirements for water.
- ***Security***. Unfortunately, cattle theft, dog attacks and damage to infrastructure can occur in Indonesia. Risks are lower for cut-and-carry operations although in many areas small-holders keep cattle in communal pens at night to ensure security.
  In SISKA operations risks can be higher because of semi-wild dog attacks or disputes with the plantation surrounding villages competing for grazing area for their cattle. Knowledge of and capacity to work with local communities is essential.

Mature (above) and establishing (below) oil palms

Getting the admin right!

Ineffective business administrative practices represent a grave danger to live animal enterprises. Timely purchasing of feed concentrate, vet products, equipment and spare parts is essential and the cattle breeding SOPs need to ensure this. Where SOPs are inflexible and procurement is delayed, the results can be catastrophic to profitability and animal welfare.

Imported and local breeding stock

- ***A market for the cattle produced***. Location and scale will impact access to the range of possible markets. Indonesia is fortunate in having a strong demand for entire (not castrated) male cattle at key annual religious festivals. It is possible that production capacity from a commercial enterprise in a remote location may exceed the demand from the festival market. Additional markets will need to be accessed for excess bulls and other classes of cattle.

It will be expensive for cattle breeding operations in remote locations to access feedlot and slaughterhouse markets. The cost and availability of transport and related infrastructure – dedicated shipping, ports, loading facilities, holding yards – needs to be considered during the planning phase. Significant shrinkage, injury and mortalities can be expected when high animal welfare standards are not followed.

- ***Cattle production is a 24-hour business***. Cattle require supervision on a full-time basis, including during holidays and religious festivals. Cattle do not take holidays!

1.3.4. Breeder cattle

The ideal breeder herd is fertile, of quiet temperament, has high growth potential and is tolerant of the local environmental and management conditions. Section 2.1 provides detailed information on cattle selection. Options for cattle purchases include:

- Purchase of local versus imported heifers
- Purchase of local versus imported bulls
- Purchase of bulls for natural mating or use of artificial insemination
- Purchase of empty heifers versus pregnant heifers
- The number of cattle to be purchased – generally a minimum of 300 breeders for a commercial company and between 20 to 100 breeders for a cooperative depending on the number of its members.

Table 1: Cost and considerations when purchasing heifers and bulls

Source and status	Cost landed Kalimantan	Considerations
Australian BX heifers (empty)	Rp 18 million	Generally of reasonable quality and temperament. Tolerant of transportation issues. Fertility is unknown. Growth potential of progeny is generally good. High levels of infrastructure are required. Not recommended for small-holders lacking resources
Australian BX heifers (pregnant)	Rp 28 million	Generally of reasonable quality and temperament but often with low overall fertility. Intolerant of transportation issues. Require a high level of post-arrival care. Growth potential of progeny is generally good. High levels of infrastructure are required. Not recommended for small-holders lacking resources.
Indonesian PO heifers	Rp 14 million	Of unknown quality and temperament. Generally highly fertile. Tolerant of transportation issues. Well-adapted to local feed regimes. Growth potential of progeny is variable but often low. Infrastructure inputs required are minimal. Recommended for small-holders lacking resources.
Australian BX bulls	Rp 61 million	Good fertility, quality and temperament. Growth potential of progeny is good. Will require 2–3 months adaptation period post-arrival.
Indonesian BX bulls	Rp 27.5 million	Unknown fertility, quality and temperament but can have high libido and be well-adapted to Indonesian conditions. Growth potential of progeny is variable. Ready to work immediately post-arrival.

Pregnant heifers are more expensive to buy but give the enterprise the benefit of generating early revenue. There are risks associated with pregnant heifers. Losses during transportation will be higher than for empty heifers if cattle are badly stressed (see Section 2.2. Transportation).

Pregnant heifers immediately require good quality feeds as do cows to maintain their good condition through late pregnancy and lactation. Infrastructure and management capacity will need to be prepared well in advance of the calving period. In summary, the importation of pregnant heifers puts considerable extra pressure on capacity and resources and should be considered only by highly experienced operators.

Bulls for natural mating are normally preferred in SISKA, extensive and semi-intensive systems but can be more difficult to manage in a breedlot.

1.3.5. Infrastructure requirements

Investments in infrastructure are critical to effective management of a cattle enterprise. The challenge is to keep the initial investments as targeted as possible, focusing on the development of essential quality assets that can be expanded as the business grows.

Australian cattle are raised in extensive rangeland systems as a herd. They have little experience of being in proximity to people and may initially be shy. This presents a challenge where large numbers of cattle are imported. Fully equipped cattle handling yards and fencing is essential. Smaller numbers will adjust to the local management culture more quickly as they can be handled intensively after arrival. Local cattle do not require the same level of infrastructure.

After cattle and possibly land, the stockyard will be the next major investment required. Build a stockyard that suits your initial requirements but can be expanded as the herd and business grows. Other infrastructure investments will include: water and water troughs, and permanent and electric fencing. See Section 2.10 for more information on stockyards and other infrastructure.

Table 2: Example of up-front investments and operational costs for a SISKA enterprise

Investment and operational costs	Cost
300 empty Australian BX heifers	Rp 5,400,000,000
10 Australian BX bulls and 5 Indonesian BX bulls	Rp 747,500,000
Cost of stockyard incl. fences, race and crush for 200 head	Rp 200,000,000
Electric fencing: Gallagher brand, 1 set of reel-geared 400 m, tester faultfinder, energiser, solar panel, etc	Rp 133,500,000
30 ha open pasture development @ Rp2,000,000/ha	Rp 60,000,000
Water pump, pipe and hydrant	Rp 20,000,000
Tractor rental (2 hours /day at Rp200,000/hour)	Rp 146,000,000
Direct labour costs – year 1 (cattle management and feeding)	Rp 550,000,000
Ration costs – year 1 (assume supplement to pasture base)	Rp 440,000,000

Infrastructure includes yards, sheds and fencing.

1.3.6. Labour and human resources

There is a general lack of labour skilled in cattle breeding in Indonesia. This can be a particular constraint in remote locations, such as the SISKA plantations in Kalimantan and Sumatra. Good livestock attendants are attentive to issues arising in the herd, addressing them before they become problematic. This is particularly important around calving and weaning. Human resources are also required for administration, record-keeping and security. Casual labour is required for weed control, feed mixing and feeding, cleaning yards, etc.

Benchmarks from active cattle breeding enterprises in Indonesia suggest that a ratio of one stock attendant to 100 cows should be achievable in efficiently managed, extensive systems. Higher labour inputs will be needed for intensive production systems. Factors that reduce labour efficiency include:

- Infrastructure factors:
  - Inefficient systems for provision of water and feed supplementation - ideally, cattle should be able to drink and feed as they wish without human input.
  - Inadequate fencing and poorly designed cattle handling facilities – you must be able to control your herd/s at all times without stressing cattle. Poor fencing and yards result in higher labour costs and reduced herd performance.
  - Long distances between paddocks, poor road infrastructure and poorly located stockyards increase labour use.
- Cattle factors:
  - Cattle with bad temperament require higher inputs and will cost you more directly and indirectly – never purchase aggressive cattle and always cull aggressive cattle from your herd – bulls, cows, weaners and heifers.
  - Too many small groups of cattle, each of which requires supervision.
- Management and labour factors:
  - Stock attendant without experience in handling cattle – a smart attendnt will move cattle efficiently if the infrastructure is designed and maintained properly
  - Staff who are not fully committed to achieving a timely result – untimely attention to sick cattle, declining BCS, etc. will increase labour requirements
  - Inefficient administration systems that delay procurement.

There is an assumption that once a breeding enterprise has been operating for 3–5 years the staff will have been “trained” – able to operate at an effective level. Experience suggests that this is not always the case. Staff require structured training on top of their on-the-job training and need to be supported to apply their learning. Only then will staff function effectively to support profitability of the enterprise.

Local labour will need good training and supervision.

1.3.7. Cattle feeds

Cattle require good quality feeds to function properly and be productive. Pasture is normally the lowest cost feed in breeding systems but in most cases will need to be supplemented with concentrate feeds to sustain condition of grazing cows. For example, a sufficient quantity of understory native grasses in oil palm plantations can provide a maintenance feed for dry cows but will not sustain pregnant or lactating cows.

Fodder banks and specialist pastures can be developed to provide additional high-quality feeds to meet this shortfall. In the absence of these improved pastures, additional supplements must be fed to increase intake of protein, energy and minerals. Numerous by-products are available in much of Indonesia and will form the basis of your concentrates. See Section 2.3 for more information.

There is a common adage that "Happy cows are profitable cows". Whilst this basic premise may be true, it will depend on the ability of the enterprise to identify and procure low-cost feed options of the necessary quality for each class of stock. What is more commonly correct is that unhappy cows will be unprofitable! Cows with low BCS will have long calving intervals, will be more susceptible to calving problems, produce lighter calves and calves that grow more slowly than calves from cows that are happy – BCS maintained at ≥3.0.

Targets for feed costs and associated labour costs need to be established for breeding and fattening components of the cattle enterprises. The IACCB program has recorded actual daily feed and operational costs for its partners (Table 3) and has also established benchmarks based on experience to date. (See Module 4. Monitoring and Evaluation).

Table 3: Daily feed costs for several IACCB partner operations

Type of operation	Class of cattle	Daily feed cost	Daily operational costs	Total daily costs
SISKA 1	Grazing cows	Rp 3,900	Rp 5,300	Rp 9,200
SISKA 2	Grazing cows	Rp 5,300	Rp 4,400	Rp 9,700
Cut-and-carry 1	Breedlot cows	Rp 10,500	Rp 2,100	Rp 12,600
Open grazing	Grazing cows	Rp 2,600	Rp 3,400	Rp 6,000

Pasture is the cheapest feed.

Cattle need supplements when grazing poor quality pasture.

1.3.8. Producing a marketable product – the on-farm part of the value-chain

In commercial beef cattle breeding enterprises, the cost of producing a calf is higher than the potential sale price of the calf because: a) the costs of the cow are attributed to the calf because it is the calf that is the marketable product; and b) it is difficult to sell very young cattle at a good price. This means that a breeding operation will not be profitable by selling its calves or selling its weaners.

In order to thoroughly understand the value chain of breeding, growing and fattening cattle, the manager must know the costs incurred to produce a weaner, the added costs to grow that weaner to a feeder weight, and then the costs to finish the animal to a slaughter weight.

Profitability is achieved by growing the calf to market-ready weight as efficiently as possible (see Table 4). The ability of the manager to grow the calves, weaners and feeder cattle at a cost per kilogram lower than the selling price / kg will determine profitability.

Table 4: Profit / loss from selling weaners, feeders and finished cattle from a 300-cow SISKA breeding operation

	Cost of input / rate	Notes
Annual cow costs	Rp 5,050,000	Includes purchase price of cow less residual value, share of infrastructure, operational and direct costs
Weaning rate achieved	65%	This is a good, but achievable, weaning rate for SISKA
Cost of producing 80kg weaner	Rp 7,614,000	All costs associated with producing an 80kg weaner
Sale value of weaner	Rp 5,200,000	Assume value of Rp 65,000/kg
Profit (loss)	(Rp 2,414,000)	A loss of over Rp 2 million by selling the calf as a weaner
Cost of producing a 320 kg feeder bull	Rp 11,395,000	All costs associated with producing a 320kg feeder
Sale value of feeder bull	Rp 15,600,000	Assume value of Rp 45,000/kg
Profit	Rp 4,205,000	A profit of over Rp 4 million is achieved by feeding the weaner and selling as a 320kg feeder
Cost of producing a 500 kg bull	Rp 17,613,000	All costs associated with producing a 500kg fat bull
Sale value of fat bull	Rp 24,400,000	Assume value of Rp 45,000/kg (can be higher if sold into Qurban market)
Profit	Rp 6,787,000	A profit of almost Rp 6.8 million is achieved by feeding the grower and selling as a fat bull

This is where the cost-of-gain at each potential sale point needs to be considered.

In developing a marketable product, the cost of each kilogram of liveweight added, or cost-of-gain, is an important consideration. Low-quality feeds may be cheap to buy but may not provide the lowest cost of gain. But expensive feeds may not necessarily provide the best return on feed cost.

Mixing feeds and by-products to form a ration that achieves the target liveweight gain at the lowest cost per kilogram is essential in achieving profitability. It is important to seek professional advice when developing rations as they have a significant influence on overall profitability. Section 2.9 provides a range of rations and their costs. The feed options for each enterprise will be developed with consideration of the class of cattle being fed – dry or lactating cows, calves, weaners, growers and bulls – and the availability and quality of pastures, forages, by-products and concentrate feeds that are locally available and their costs.

1.3.9. Markets

The enterprise should identify its target markets as part of its pre-start-up financial viability assessment. Markets are location specific in terms of stock classes required, ability to absorb production, sales basis – per head or per kilogram liveweight, and price. Regional markets are commonly structured to meet cultural and social norms rather than typical western considerations of weight and meat quality. Table 5 provides some potential markets and average prices for various classes of stock.

The Qurban religious festival market is a reliable high-price market. However, at some point this market will reach saturation. There is also a preference for smaller-framed cattle as the price per head is more affordable for local communities.

Lighter cattle are also preferred in regional areas where few butchers have refrigeration. The whole carcase must be sold through the local "wet market" in a single day to avoid spoilage and associated financial losses.

Sales to feedlots and slaughterhouses are location dependent. Transport of cattle is generally expensive in Indonesia, particularly if sea voyages are required. These factors must be considered in determining revenue projections.

Table 5: Markets and prices for various classes of sale cattle

Class of stock	Weight range (kg)	Market	Price Rp/kg[1]
Bulls			
– mature	400–600	Qurban	65,000
– aged cull	500–650	Abattoir	40,000
– young working	500	Breeding companies	60,000
– grower	150–350	SH[2] fatteners	50,000
		Feedlots	45,000
– weaner	100–150	SH fatteners	75,000
Heifers			
– mature	280–340	Breeding companies	45,000
– cull	280–340	SH fatteners	45,000
– weaner	100–150	SH breeders	60,000
Cows			
– cull- low BSC	300–400	Abattoir	40,000
– cull- fat	400–550	Abattoir	40,000

[1]Average prices as of early 2019

[2]SH = smallholder cattle farmer

1.4. Key performance indicators

A range of key performance indicators (KPIs) are used across all cattle breeding enterprises. These KPIs provide essential information on the productivity and efficiency of the operation and are listed below. Financial viability assessment models will require estimates of most of these KPIs to generate an outcome. They are typically the outputs of herd management software or spreadsheets, being generated from input of production data.

Table 1: Key performance indicators for commercial breeding operations

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
BCS (body condition score)	An indicator of cattle condition – essential to achieve high calving rates	Using an industry standard scale 1 to 5	Cows ≥3.0 Bulls >3.5	BCS is a visual assessment of muscle / fat cover of cattle. Cows with low BCS will be unproductive. Weaners and growers are evaluated on ADG, not BCS
Conception rate	Percentage of cows getting pregnant in a 12-month period	Number of pregnant cows divided by number of breeding females in the opening stock position	KPI >90% for cut-and-carry KPI >80% for SISKA	A high conception rate requires cows to be in good condition (BCS≥3.0) and the availability of good quality working bulls or effective AI program
Still-birth, abortion rate	Percentage of pregnant cows that do not deliver the calf due to still birth or abortion in a 12-month period	No. of pregnant breeding females that do not deliver the calf divided by number of breeding females in the opening stock position	KPI <5% for cut-and-carry KPI 5-10% for SISKA	Generally linked to condition of cows, but also impacted by extreme humidity or heavy rain
Calving rate	Percentage of breeders delivering a live calf in a 12-month period	No. of calves born divided by number of breeding females in the opening stock position	KPI >85% for cut-and-carry KPI >70% for SISKA	The result of conception rate minus problems with abortion and birthing
Calf-mortality rate	Percentage of calves that have died in a 12-month period	No. of died calves divided by number of calves born	KPI <3% for cut-and-carry KPI 5-10% for SISKA	Related to the condition of calves and cows; the cleanliness of pens and water; seasonal factors such as intense rainfall; incidence of pests and diseases, dog attacks
Weaning rate	Percentage of calves weaned per total number of breeders in a 12-month period	No. of weaned calves divided by number of breeding females in the opening stock position	KPI >80% for cut-and-carry KPI >65% for SISKA	The result of calving rate, less calf mortality. Weaning at 100kgs/5-6 months old is recommended to reduce the calving interval. Light weaning may be possible in cut-and-carry (>80kgs at 3 mths)
Calving interval	The average number of months between calves for each cow	The average number of months between calves for each cow	13 months for cut-and-carry; 15 months for SISKA & open grazing	Much easier to achieve in breedlot than in SISKA and open grazing systems. Does not factor in cows that have not calved in the target year
ADG- weaner / feeder growth rates	Average daily gain (ADG) of weaners and feeders	ADG of weaners 100kg – 320kg expressed as kg/head/day ADG of feeders >320kg liveweight	ADG 0.5kg/head/day for weaners ADG 0.6kg/day for feeders	Growth rates heavily depend on quality and quantity of feed rations and can be much higher than the suggested KPIs
Cost-of-gain	Variable or direct costs to produce 1kg liveweight	Feed and labour or only feed costs required for a grower to gain 1kg	Rp20,000 to Rp35,000	The cost-of-gain largely determines the profitability of the enterprise.
Cattle mortality rate	Percentage of cattle population that has died in a 12-month period	No. of died cattle divided by number of cattle in the opening stock position	KPI <3%	Generally low for companies with good management- BCS ≥3.0, capable stock handlers, etc.
Culling rate	Percentage of cattle population culled due to sickness, bad temperament or poor growth	No. of culled cattle divided by number of cattle in the opening stock position	Determined based on company objectives and initial stock quality	Unproductive cows and bulls should be culled from the herd. Improve herd genetics with additional culling to meet company objectives

1.5. The business cycle

The business cycle for a cattle breeding enterprise is typical of any business in that it comprises a start-up phase, an expansion or growth phase and a mature enterprise phase.

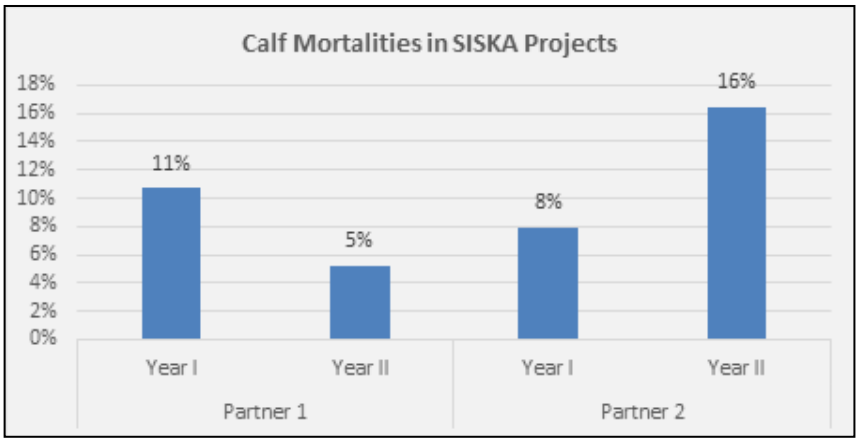
1.5.1. Start-up

The start-up phase generally runs from commencement to 3 years or at least until the first sales of marketable cattle – either feeders or fat cattle – has been completed. Start-up is a period of trial and error that can strongly impact long-term viability. It is important to learn from the experiences of those that have been through the process already.

Cattle breeding companies are encouraged to meet regularly to share their experiences through peer-to-peer learning for advancement of commercial cattle breeding in Indonesia.

Site specific issues can only be addressed by carefully observing the cattle condition and surrounding environment through the various phases and seasons. Not all issues will be experienced in Year 1 and good staff and managers never stop learning. Figure 1 shows how calf mortality increased at one partner (P2) due to the extreme environmental conditions experienced in that year.

Figure 1. Calf mortalities in SISKA Project (as at May 2019)



If all goes well, the condition of cattle will at least be maintained throughout the start-up phase. A new enterprise should be keenly aware of declining cattle condition and be ready with supplementary feeds of appropriate quality.

In this early phase of development, the investor should understand the extent of initial capital and operational costs which cover the cattle pre-arrival costs, overheads and the availability of basic cattle handling equipment to support the operations. In most breeding operations it will take 6 to 8 years to recover the cost of initial investment, although the range can be 4 to 9 years. The investor should also be ready to support investment for additional infrastructure that will be needed as the herd grows.

1.5.2. Expansion phase

The expansion phase will last as long as it takes for the enterprise to achieve its target for breeder numbers. Efficiencies of scale can normally be expected from larger herds. Herd growth will be achieved organically by retaining heifers. Breeder numbers might expand at 30% annually by retaining the best heifers, depending on culling rates and the quality of progeny. Purchasing additional heifers will fast-track the expansion phase but significantly increases the cost. The capacity of staff to manage the rapid scale-up must also be considered.

Significant improvements across all KPIs will generally be achieved by good management during the expansion phase. KPIs that can generally be improved include conception, calving and weaning rates. Mortality rates should steadily decline. BCS should become less volatile and should never dip below 3.0.

The cost-of-gain for weaners and feeder cattle should gradually decrease, driven either by lower feed costs or higher growth rates for the same ration costs. The cost of maintenance and recovery rations for cows should also gradually decline, without sacrificing BCS.

1.5.3. Mature phase

The mature phase starts once the enterprise has reached its target number of breeders. Improvements across KPIs are generally more modest during the mature phase as lessons learned previously have resulted in best practices being adopted.

Table 1: Key factors to be considered in the various phases of a cattle operation.

Phase	Period	Considerations
Start-up	0-3 years or at least 1 calving cycle	Learn from others with experience before commencement Learn from trial and error specific to the enterprise, but do not ignore the advice of experienced operators Carefully observe the impact of weather, feeds and management practices on cattle condition Develop human resources to be acutely aware of herd issues Maintain the BCS of cows at ≥2.6 at all times Don't over-spend on infrastructure Use a functional herd and finance recording system from the outset – sound record keeping is essential to improvement.
Expansion – extra investment in infrastructure as the herd grows.	3 – 5 years or after 2nd calving cycle / sale of marketable cattle	Retaining heifers and increasing the herd whilst maintaining cattle condition Develop your staff and the feed base as a basis for growing your herd Fine tune record keeping as the processes and systems are established First market-ready cattle are sold – fine tune the marketing options and processes.
Mature – additional allocated budget may be needed.	Above 5 years	Stabilise the herd size cattle condition Continue to identify profitable markets for sale cattle Continue to improve weaning rates, feed quality and weight gains Create efficiencies with internal systems and procedural improvements.

1.5.4. Main factors across all phases

The main factors affecting business success across all phases are:

- *Management buy-in.* Owners, managers and supervisors must have a passion for cattle production to persevere through the challenges that will arise. This includes a commitment to ensuring the welfare of their cattle as a primary element of success.
- *Maintaining the condition of the breeder herd*. Cost effectively maintain all breeders at a BCS of ≥2.6. Any cows with a score below this should immediately receive a recovery ration. Do not stand-by and watch the BCS of your cows drop! Positive action is essential to achieving high conception and calving rates.

- *Achieving the highest possible weaning rate*. Being the outcome of conception less losses from abortions, still-births, and calf-mortality, the weaning rate is a key driver of early success. Stockmen have a key role to play in rapidly addressing animal health issues in calves to achieve the highest possible weaning rate from the calves born.
- *Minimising feed costs for breeders without decreasing BCS*. This is usually driven by the availability of pastures and good quality forages in combination with provision of low-cost concentrate feeds based on locally available agricultural by-products.
- *Achieving the highest possible average daily gains for weaners*. Weaner and grower growth rates drive profitability. Targets should be at least 0.5 kg per day in the medium-term, although 0.4 kg per day may be more realistic initially. Seek professional advice on developing rations or supplements for your weaners and feeder cattle.
- *Achieving the targeted cost-of-gain*. Linked to the growth rates of weaners, growers and feeder cattle is the requirement to achieve the targeted daily liveweight gain at the lowest cost of ration possible.
- *Successful operational integration*. Developing efficient working relationships with all components of integrated businesses. This is especially important for SISKA systems, where the cooperation of the plantation component is critically important to underpinning the profitability of the cattle component.
- *Developing a skilled and committed workforce*. Skilled and committed staff will reduce mortalities and variable costs and increase weaning rates, daily gains and overall profitability. Clear task distribution among employees or members of each operational unit is also important.

1.6. Cash flow, payback period and Internal Rate of Return

IACCB has developed an understanding of the potential outcomes of cattle breeding enterprises in Indonesia through monitoring of several new enterprises. All projects achieved an internal rate of return (IRR) of between 9 and 18% at year 10 based on returns from cattle alone (and using terminal value modelling). Initial findings show that when combined with the impacts of grazing cattle in oil palm plantations, the IRR increased to 10–20%. The increase in IRR is due to reduced weeding cost and an approximately 10% increase in fresh fruit bunch yield.

Under good conditions and starting the enterprise with pregnant heifers, it is possible to generate a positive cash flow in the second year of operations especially when operational costs are low and progeny is sold at an early stage. Cashflow is helped when there is a market for manure or for compost produced using the manure. However, there are significant risks associated with purchasing pregnant heifers (see Section 3.1 Breeding business). Where empty heifers are purchased, positive cash flow is generally achieved during year 3 (and up to 4 years). The pay-back period for a 300-cow operation typically occurs at 4 to 9 years after commencement, depending on weaning rates achieved and whether an increase in FFB yields can be measured after three years.

IACCB's financial model, CALFIN, is able to generate outputs for a range of scenarios based on various KPIs. The model enables a potential investor to assess the suitability of a potential cattle breeding investment to their risk profile and financial resources. (See Section 4.1)

Table 1: Internal rate of return (IRR) and payback period for a SISKA operation achieving various weaning rates and with / without reduced weeding costs and at different weaner growth rates

Weaning rate	**60%**		**70%**		**80%**	
SISKA with 300 breeders	**IRR**	**Payback (yrs)**	**IRR**	**Payback (yrs)**	**IRR**	**Payback (yrs)**
Assume growth rate of heifer weaners/feeders = 0.35; bull weaners/feeders = 0.04						
Incl. Rp65,000/ha saving on weeding from yr 3	10.6%	8	17.6%	7	23.7%	7
No benefits from FFB yield or reduced weed control costs	9.3%	9	16.7%	7	23.1%	7
Assume growth rate of heifer weaners/feeders = 0.40; bull weaners/feeders = 0.45						
Incl. Rp65,000/ha saving on weeding from yr 3	11.5%	7	18.8%	6	24.7	6
No benefits from FFB yield or reduced weed control costs	10.2%	8	17.9%	7	24.1	7

1.7. CALFIN Breeding enterprise modelling

Various spreadsheet and software packages are available to determine the financial viability of an investment in beef cattle breeding. IACCB has developed a Microsoft Excel-based financial model specifically for Indonesia.

CALFIN – Cow-calf Operations Financial Model has two versions:

1) a static version that uses standard input variables across the entire prediction cycle with limited cattle sales options

2) a dynamic version in which variables can be changed for each year and more variety of cattle sales options.

The spreadsheet provides the minimum level of complexity required to undertake an informed assessment of commercial viability. It determines production over a 10-year period to generate a series of reports including: net present value, internal rate of return, return on investment, payback period, breakeven point, profit and loss and cashflow.

As with all models, it is only as accurate as the information and assumptions that drive it. Because predicting expenses and revenues 10 years into the future is challenging, the ability to compare a range of investment, production and marketing scenarios has been included, ranging from conservative to optimistic.

The spreadsheet has the capacity to generate outcomes for integrated systems, in particular SISKA where it allows the consideration of the impacts of cattle on weed control costs, oil palm yield and other options to generate income.

Using data derived from actual cattle breeding enterprises, the spreadsheet indicates that there is potential to develop profitable cattle breeding enterprises in Indonesia. Break-even periods are commonly approximately 6 to 8 years, but can range from 4 to 9 years. The internal rate of return should be in the order of 10% to 17%, but can range from 9% to 24% depending on cattle management and the potential to include benefits to the oil palm plantation. Factors that strongly impact financial outcomes include:

- Scale of up-front investment
- Weaning rates – ranging from 60% to 80% (or lower for poorly managed operations)
- Feed costs – generally ranging from Rp3,000 to Rp13,000
- Sale prices – ranging from Rp40,000 to Rp70,000/kg liveweight
- Stimulation of oil palm yields from improved nutrient cycling – ranging from 0 to 12%

IACCB has developed two other tools to support Indonesian cattle breeding investors.

CALPROS: Cow-calf Operations Productivity Spreadsheet is for monitoring the productivity of breeders and their progeny. Based on Microsoft Excel, it can be used by new actors in the cattle breeding industry to monitor their operations.

CALPROF: Cow-calf Operations Software, produced in collaboration with a local software developer, enables a company to track progress and profitability, and generates a record of key performance indicators. More information is available in Module 4 – Enterprise Monitoring and Evaluation.

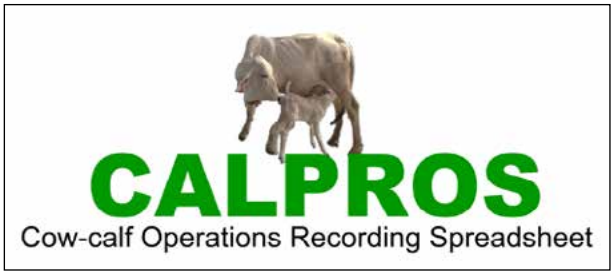
CALFIN: Cow-calf Operations Financial Planning Model

CALFIN is an enterprise level financial model to support cattle breeding investors in their decision making. The Microsoft Excel-based model will be valuable for oil palm companies, feed-lotters, breed-lotters and smallholder groups as well as banks, financial institutions, donor and government agencies. The model has considerable flexibility in its parameters, covering investment costs, the breeding system used, herd size and performance, operational and feed costs, and all production and marketing parameters. There are two versions of the model: 1) a static version, that uses standard input variables across the entire prediction cycle; and 2) a dynamic version, for which variables can be changed for each year.

The spreadsheet provides the minimum level of complexity required to undertake an informed assessment of commercial viability. It determines production over a 10-year period to generate a series of reports including: cash flow, net present value, internal rate of return, return on investment and payback period.

Default Data is also included based on IACCB's experience to date, allowing users to get started without possessing their own data for some or all parameters.

CALPROS: Cow-calf Operations Productivity Spreadsheet for Monitoring



IACCB developed CALPROS as a tool for cattle breeding businesses to monitor the productivity of breeders and their progeny. The CALPROS spreadsheet is based on Microsoft Excel and can be used by new actors in the cattle breeding industry. It is specifically developed for new enterprises to ensure they are able to monitor their operations without having to buy expensive software thus reducing start-up investment costs at the start of their enterprises.

CALPROF: Cow-calf Operations Software

Produced by a commercial software developer, CALPROF is a robust cattle herd management software for Indonesian Cattle Breeders that support day-to-day cattle operations, specifically breeding, fattening, and feeding.

The software has integrated features that manage productivity (e.g. pregnancy tests, weighing, calving) linked to a Radio-frequency identification (RFID) reader, financial (e.g. feed costs, cashflow), and operational data (e.g. shipments, procurement, feed intake and nutrition, concentrate formulation and production, animal health, cattle movement). The software also generates reports that can support cattle breeders to monitor and evaluate their business performance.

2.1. Cattle selection

2.1.1. Introduction

The right genetics/breed/cattle for your enterprise

Imported Brahman bull and heifers under oil palms

Imported breeding stock must be suited to the local environment. This means that they must be adapted to the high temperatures and humidity of the tropics and able to reproduce under sometimes marginal nutrition.

All stock should be at least 75% *Bos indicus* and hence of Brahman, Afrikander or Senepol stock, with suitable coats, tick resistance and without horns. Ideally bulls should be 3 years old and over 500 kg liveweight, and heifers over 2 years and 350 kg – Brahman heifers below this weight may still be reproductively immature.

Temperament and its role in herd productivity

All imported stock should have good temperament and be accustomed to human control. Aggressive animals can injure other animals and humans, and are difficult to manage in the field. If after a period of settling in to local handling, an animal remains difficult to manage it should be culled.

Coordinating selection, shipping and trucking of imported cattle

Coordinating shipping of imported stock

The usual time line of Indonesian Government livestock purchasing is that the decision-making process begins early in the calendar year. A firm decision on numbers and funding allocation occurs around May/ June.

The next step in the process is the letting of tenders to allow importers to bid for the various shipments. Successful tenderers are notified in about July and then commence to finalise their purchase negotiations with their export supplier. This process may not take place until July/August or later.

The exporter must then identify a suitable vessel, locate and purchase the stock required to fill the order, and send a Notice of Intent to Send an Export Consignment to the Australian Government. Thus it may be August/September before stock are actually selected and purchased. The selection, purchase and quarantine period will add another month so the animals are ready for shipment in September/ October/ November. Arrival in Indonesia will coincide with the start of the rainy season – the most stressful time of the year to introduce new cattle.

The cattle breeding cycle in northern Australia is driven by the annual monsoon where rain falls in November – March and females get pregnant during this period in association with green grass and rising planes of nutrition. As the 'average' heifer conceives during February to March, by selection time in August/September she is at or over the cut-off pregnancy term for safe exports (no more than 6 months pregnant).

These two immovable schedules are naturally opposed to each other. Unless one schedule is changed, there will always be a conflict with the timing of the purchasing and importation of pregnant breeding heifers from Northern Australia into Indonesia. With careful planning it should be possible to manage the arrival of cattle to coincide with a low-stress seasonal period.

2.1.2. Selecting imported heifers

The Indonesian Government health protocol requires that heifers be examined to ensure that they appear to have normal reproductive capacity and are not showing any faults that might impair their ability to conceive and rear a calf.

Cattle need to be able to eat normally and be able to walk long distances to find food and water. Jaws and legs need to be well formed, with a normal udder.

Check Government of Indonesia protocols for the latest regulations and specifications for importing heifers.

Imported Brahman heifers

Recommended specifications

Heifers should be examined to ensure that they have not been spayed – check for a spay mark in the ear and, if unsure, check through rectal palpation.

Heifers' ears should be checked to ensure that they have not been treated with Hormonal Growth Promotants (HGPs). Animals treated in Australia are identified with a small triangular punchhole in the ear, while sometimes, the marker of the HGP remains in the ear. Treated heifers should be rejected.

As all heifers need to be rectally palpated to detect their pregnancy status they should also have their reproductive tract manually examined to confirm that it appears to be normal.

Fertility and growth rates

Northern Australian cattle have been aggressively selected for growth. As a result, they are much larger than local *Bos indicus* cattle and they need much more food each day in order to maintain their condition, grow and reproduce. When they are fed properly, their growth potential is extremely high, and this is why Australian cattle are preferred over local cattle in feedlots.

Cattle from the harsh, dry environment of northern Australia have been naturally selected over the years to be less fertile than Indonesian cattle. This is because if a cow in northern Australia becomes pregnant when in poor condition – BCS <3 – it will be in serious danger of dying during the long dry season. Cows that get pregnant only when they are in good condition (BCS ≥3) have a much higher survival rate and have gradually become the genetic majority within the breeding herd.

Northern Australian cattle are also naturally selected for lactational anoestrus for the same reasons. If a lactating cow gets pregnant in a northern pastoral environment, she is unlikely to be unable to maintain herself, her foetus and her suckling calf during the long dry season. Cows exhibiting lactational anoestrus have a greater survival rate than their more fertile sisters and therefore become the dominant genetic type.

If calves are weaned at around 100kg at 5–6 months, most Australian cows of BCS ≥3 will cycle and become pregnant rapidly. In the wetter regions of Indonesia, it will still be possible to achieve a calving rate of 80% across the herd with a calving interval of 15 months. Good nutrition is the key factor in achieving this outcome.

Comprehensive information on the transportation of cattle to and in Indonesia has been compiled in ***Best practice guide for the transport of cattle in Indonesia***.

The guide is available in both English and Bahasa Indonesia languages.

General information and the link to the Best Practice Guide can be seen in Module 3 – Transportation of cattle in Indonesia.

2.1. Cattle selection

Good quality local BX cow with calf

Pregnant or non-pregnant?

The choice of pregnant or non-pregnant heifers will often depend on the status of the enterprise when the heifers arrive. Pregnant heifers suffer more stress during transport and must be delivered to low-stress high standards of husbandry.

Non-pregnant heifers are preferred if a new enterprise has inexperienced stockmen. Exporting non-pregnant heifers will result in a significantly longer period before calves are born and income is generated.

Local or imported?

Some cattle enterprises may be best served by purchasing local breeders. Local breeding cattle are usually highly fertile but have lower growth rates and less terminal weight than imported cattle.

The main considerations are:

- Are such animals available?
- Is the quality sufficient to warrant joining the breeding enterprise?

If local heifers are available, genetically superior calves can be bred by using high-quality bulls or AI.

Table 1: Cost and considerations when purchasing heifers and bulls

Source and status	Cost landed Kalimantan	Considerations
Australian BX heifers (empty)	Rp 18 million	Generally of reasonable quality and temperament. Tolerant of transportation issues. Fertility is unknown. Growth potential of progeny is generally good.
Australian BX heifers (pregnant)	Rp 28 million	Generally of reasonable quality and temperament but often with low fertility. Intolerant of transportation issues. Require a high level of post-arrival care. Growth potential of progeny is generally good.
Indonesian PO heifers	Rp 14 million	Of unknown quality & temperament. Generally highly fertile. Tolerant of transportation issues. Well-adapted to local feed regimes. Growth potential of progeny is variable but often low.
Australian BX bulls	Rp 61 million	Good fertility, quality and temperament. Growth potential of progeny is good. Will require 2–3 months adaptation period post-arrival.
Indonesian BX bulls	Rp 27.5 million	Unknown fertility, quality and temperament. Growth potential of progeny is variable. Ready to work immediately post-arrival.

Fertility and growth rates

Indonesian cattle have been selected to be highly fertile. Indonesian smallholder farmers actively cull cows that do not get pregnant quickly, regardless of their BCS and lactational status.

Over a period of more than half a century, this selection pressure has resulted in a cow herd that conceives at a low body condition score and often while suckling its previous calf – known as lactation oestrus.

This selection pressure also tends to decrease the body size of the local cow, which in turn means that its daily nutritional requirements are substantially less than a much larger animal. The birth weight of its calves will be small and their growth rate and terminal size will also be lower than that of Australian cattle.

2.1.3. Selecting bulls

Recommendations when purchasing Australian bulls

1. Establish your purchasing criteria and specifications. They should include:
   - breed
   - age and weight
   - temperament
   - health protocols
   - fertility tests
   - naturally polled
2. Buy bulls with a delivery schedule designed for them arrive at their destination at least three months (preferably four) before they are expected to join with breeding females.
3. Buy well-grown bulls. The Indonesian Government protocol has a maximum age limit of 36 months. Try to buy bulls at this age and with a minimum body weight of 500 kg.
4. All bulls should undergo a VBBSE and a Morphology test to ensure the bulls have the capacity to mate.
5. Where possible, buy bulls which have been DNA tested for the heterozygous Poll gene. Polled bulls will produce progeny that do not grow horns – desirable in a grazing herd.
6. In addition to the Indonesian protocols, it is highly recommended that bulls should be vaccinated for: Vibriosis, Pneumonia , IBR, BVD, Leptospriosis, Clostridial diseases and Ephemeral fever. These diseases will affect calving rates and the vaccines are not available in Indonesia.
7. Place insecticide tags in all bulls as they leave Australia to ensure that they at least have a few months protection from biting insects after arrival. After this, use back-rubbers or other means to provide further protection if insecticidal tags are not available.
8. Train receiving cattle managers to use the correct techniques for low-stress handling and management so that the bulls can recover from their journey as quickly as possible in the new environment. Also brief the receiving stockmen on the potential problems of working with large bulls which can be dangerous, particularly if handled poorly.
9. Try to ensure spare bulls are available and ready. Be prepared to remove injured or stressed bulls to recovery areas and to replace them with fresh animals. Local bulls could be used if there is enough lead-time to prepare them appropriately.
10. Train bulls to accept individual supplementary feed under grazing conditions – this will improve ease of handling and provide breeding bulls with sufficient additional nutrition to keep working while still maintaining strength and body condition. A highly concentrated supplement mix could contain 1–2 kg of soybean meal, rice bran, onggok, rice or corn and molasses.

For more information on Bull breeding soundness examination (VBBSE), go to https://www.ava.com.au/cattle/bullcheck-public

Selected Brahman bulls

Bulls will become tame enough to be hand fed.

2.1. Cattle selection

Government of Indonesia regulations concerning importation of ruminants:

Article 17. Large Ruminant Specifications as referred to in Article 5c for Productive Males: a) normal reproductive organs; b) aged 24 months to 36 months; and c) free from physical disabilities such as abnormal eye, foot and nail defects, and no spinal abnormalities or other bodily defects.

Potential problems

- Imported bulls frequently arrive later than the ideal time in herd management.
- The bulls are normally stressed after their long journeys, stress is sometimes exacerbated when they arrive during severe monsoonal conditions.
- The stress of relocation may result in bulls being infertile for three or more months after arrival.
- Imported bulls may be too young (under two years) and too light in body condition to immediately withstand a heavy mating work load.
- Bulls coming from feedlots can quickly lose body condition and virility under the marginal nutrition of some grazing environments and heavy workloads.
- The Body Condition Score (BCS) and virility of bulls in the paddock can be improved with supplementary feeding and a resting period of about 2 months of minimal stress.
- The overall effects of these factors is that pregnancies are often significantly delayed, resulting in low conception rates, extended calving intervals, bull wastage and, ultimately, financial losses.

Bulls in good condition in pasture

What checks are important before purchase?

Make sure bulls have been vaccinated for everything possible regardless of what is required in the export health protocol – especially Vibriosis, Ephemeral fever, Bovi-Shield MH-One (BRD, bovine Respiratory Disease) , 7 In 1 (Leptospirosis and clostridial diseases), (3 day sickness), Bovine Virus Diarrhoea (BVD) , Infections Bovine Rhinotracheitis (IBR) as very few vaccines are available locally.

Place insecticide tags in all bulls as they leave Australia to ensure that they at least have a few months protection from biting insects after arrival. After this, use back-rubbers or other means to provide further protection if insecticidal tags are not available.

Try to ensure spare bulls are available and ready. Be prepared to remove injured or stressed bulls to recovery areas and to replace them with fresh animals. Local bulls could be used if there is enough lead-time to prepare them appropriately – that is, ensuring that they are mature and of a good size (at least 450kg liveweight) and have fully recovered from travel.

How many bulls are needed?

Normal joining ratios of bulls to females are 3% (one bull to 33 cows) where bulls have been fertility tested and known to be in good working order. Where fertility testing is not available or where bulls are known to be under stress (heavy reproductive activity, weight loss, nutritional stress, harsh weather), a higher percentage of bulls would allow some to be rested and so recover their body condition – around 5% (one bull to about 20 cows).

Thus the number needed will depend on the size of the existing breeder herd and the conditions that the bulls are likely to face once they commence joining.

As a general rule, bulls expected to join breeders under palm trees will be under greater stress than bulls based permanently in a kandang. In this case a higher ratio of bulls needs to be supplied with the total levels up to 6% to allow for a rotation of 3% joining with the cows and 3% recovering.

Imported bulls or local bulls?

Overall, Australian bulls with known fertility and production traits will be of significantly higher genetic quality than local animals. Local bulls will be of unknown genetic quality and generally vary greatly in their performance and the quality of their progeny.

However, as imported Australian bulls are likely to remain stressed and infertile for at least 10 weeks, local bulls could be used where pregnancies are urgently required.

Local bulls may also suffer some stress when being relocated. They need to become adapted to the release of their nose ropes along with strengthening their body and legs for the new-found ability to mount.

Local and importd bulls

Purchasing local bulls

Large numbers of bulls are fed in Indonesian feedlots to provide domestic supplies of fresh beef.

Some bulls in local feedlots are generally cross-breeds based on Indonesian Ongole often with AI using high quality Australian Brahmans. Many show good genetic characteristics and could be used as an emergency contingency plan when Australian live imports are not available or ready for service.

Purchasing these good local bulls from feedlots is still expensive and can have unpredictable results.

Drawbacks in their transition to breeding bulls can include:

- some have been tied up with a nose rope all their adult life
- they have never been allowed to mount a female in order to mate
- their poorly developed back and leg muscles often lead to injuries when first attempting to mate.
- they are used to trough feeding, and often lose weight under grazing.

One solution is to give them some time off the nose rope before they join the cows. Unfortunately, they then often fight with other males and sustain injuries because they are not used to this physical activity.

Some local bulls are used to nose ropes, making them easier to handle but maybe innocent for mating

Local bulls may lack stamina and can drop their body weight rapidly when introduced to a large number of cycling cows.

The practical solution is to purchase double the number of bulls required and let them off together in a pen where they have plenty of room and good bedding with a non-slip floor. They can interact and exercise their new muscles.

Bulls that do not develop injuries will be suitable to join with the cows; those that have performed poorly or are injured can be returned to the feedlot. Obviously this is an expensive means of selecting bulls even if their price is less than imported stock.

2.1.4. Experiences with bulls in the IACCB SISKA Project

Background

IACCB purchased some local bulls for the initial two projects (BKB and KAL) because the Australian bulls were to take longer to import.

An experienced selector was dispatched to Central and East Java to purchase the best local cross-bred bulls (50% *Bos indicus* and 30–50% European breed). All bulls were purchased from the breedlot model (permanently on concrete, tied up and fed well) and tested for soundness (feet and legs) and semen quality. The average cost of these local bulls was 30 million IDR delivered to the projects.

Australian bulls purchased at a similar time were paddock-bred (born and raised in the paddock with the herd). They were subject to a Bull Breeding Soundness Evaluation (BBSE) and Semen Morphology was tested before export. The average cost of the imported bulls was 60 million IDR delivered to project sites.

The status of the bull herds after two years on the 4 SISKA projects is shown in Table 2.

Table 2. Local vs. imported bulls in Years 1 and 2 (2017 and 2018)

	1. BKB	2. KAL	3. BNT	6. SUJ	Total
Local bulls purchased	12	9	0	0	21
Local bull deaths/culls	9	6	0	0	15
% local bulls deaths/culls	75%	67%			71.4%
Imported bulls purchased	8	6	13	10	37
Imported bulls deaths/culls	0	0	4	0	4
% imp. bulls deaths/culls	0%	0%	31%	0%	10.8%

Key observations

1. Cost of the bulls after culls and mortalities:
   - Local bulls: 30 million IDR *1.714 = 51.4 million IDR
   - Imported bulls: 60 million IDR *1.108 = 66.5 million IDR
   - Further culling of the local bulls is likely as they succumb to the stress of working in extreme heat and humidity
2. The high rate of deaths/culls for local bulls was due to health issues associated with their inability to adjust to the environment.
3. All bulls required several months to recuperate after arrival at the project sites.
   - Imported bulls adjusted to the environment more quickly although the stress related to a lengthy trip from Australia resulted in a delay of up to three months in their capacity to mate with the heifers.

- The local bulls were given a recuperation time (resting in pens on high-energy diets) of one week after delivery. This rest is too short. Injuries, mostly in the legs and feet, after transfer to the paddock, and rapid loss of body condition significantly delayed joining and conceptions in all herds.

4. Imported Australian bulls (minimal 75% *Bos indicus*);
   - ✓ Comfortable with the climate and grazing environment. They did not suffer injuries to feet and legs and were not prone to stress-related illnesses, such as pneumonia. This is certainly due to their breed suitability and their history of growing up in a paddock and grazing environment.
   - ✓ Can be productive to 8 years old
   - ✖ Their age upon delivery (24–30 months) was too young, and their relative immaturity delayed their willingness to mate with the heifers by 4–5 months. Older bulls (30–36 months) will be more active.

5. Local bulls (50% *Bos indicus* and 30–50% European breeding - Limousin or Simmental)
   - ✓ Displayed an apparent higher libido than the imported bulls. (Brahman bulls typically are more shy and work at night which means their activity is not observed.)
   - ✓ Are initially cheaper, readily available and can delivered within a month
   - ✓ With some European genetics, the calves are highly favoured by the local market.
   - ✖ Local bulls are reared in pens and are more difficult to select at purchase for attributes such as soundness in the legs and feet and walking ability. At purchase, bulls are tied up and allowed to walk only short distances whereas Australian bulls can be selected whilst in the paddock.
   - ✖ Displayed a low tolerance for humidity. They lacked stamina in the paddock and required frequent periods of recuperation to maintain body condition.
   - ✖ Require extended periods of preparation upon arrival at site (3–4 months). This includes adjustment to diet, exposure to weather, walking, and living in herd conditions.
   - ✖ Unlikely to be active beyond 6 years old

6. The IACCB program commenced with a generous 5–6% mating rate (1 bull to 18–20 cows). In Northern Australia, 3% is the norm but the palm plantation environment is tough for all bulls and requires a rotation of bulls to work and rest in 3-monthly intervals. Also, foliage is dense restricting the ability of the bulls to view their herd.

7. Bulls bred in the plantation are an alternative (years 3 and beyond). However, they must undergo the rigorous selection as per the normal specifications including a BBSE and Morphology test.

8. Record keeping must be good to ensure they are not mated with their own progeny (in-breeding)

In summary, although the local bulls were 50% cheaper to purchase ($3,000/local bull vs. $6,000/imported bull), imported bulls may represent better value as they have:

- Longer productive life – less prone to injury and stress-related issues
- Superior genetics – progeny will have higher growth rates due to improved genetic selection processes in Australia

Artificial insemination (AI)

Artificial Insemination is suitable only where animals are under intensive management, thus not where cattle are permanently grazing under palm.

AI is feasible where cattle are held in the kandang if the stockmen are experienced in identifying signs of heat and in the management of AI generally. There must be a competent AI service at a nearby location, and cattle yards must be modified if AI is used on imported Australian cows. Applying a nose rope and the associated delays and stress may delay the onset of cycling in heifers.

SOP for arrival of new heifers and bulls

The following comments and recommended Standard Operating Procedures are for the receival, delivery and adaption of imported and local bulls. For more detailed information see: http://www.redmeatcattlepartnership.org/media/1ZQt0-best-practice-guide-for-the-transport-of-cattle-in-indonesia.pdf

Trucks in good condition with careful drivers

Staff training

Train receiving cattle managers with the correct techniques for low-stress handling and management. This will speed up the bulls' recovery from their journey and new environment.

Brief the receiving stockmen on the potential dangers of working with large bulls which, if handled poorly, can be potentially very dangerous.

Trucking

Standard ESCAS rules must be observed; animals must be checked every hour, the truck deck must be non-slip with steel mesh and covered with sawdust or straw, there should be no protrusions and the tailgate must he firm and stable. The truck tyres should be in good condition with adequate tread.

If cattle are trucked over long distances for 12 or more hours, try to organize a rest stop with dry, clean pens and adequate clean water and fresh green chop.

First arrival

When imported stock first arrive off the truck they will be tired and weak. Unload off the truck as smoothly and quietly as possible, to make sure that the animals are not stressed.

- Ramps and truck tailgates should be checked for animal safety as per ESCAS standards.

- Spread plenty of sawdust, sand, coconut husk or bagasse on the ramps
- Make sure there are no protrusions on the side rails and gates.
- Reduce noise as the bulls are unloaded and avoid having too many people around.

Good trucks with strong side rails, safe unloading ramps and non-slip surface

Pens

A large secure yard is preferable but allow plenty of pen space (with a minimum of 6 m^2/head). The yard should not become too boggy during heavy rain.

Do not mix new bulls with any other stock on arrival, they must stay on their own until they are ready to join the cows.

A roof or shelter may not be needed unless the new bulls arrive under heavy rainfall in the monsoon.

Spread good dry bedding over the concrete so that they can rest comfortably and recover from their long journey.

Rest

Depending on the length of the journey, bulls need significant rest before their semen will be of a desired quality.

Minimum rest for a short journey (1 day) is 1 week, but allow up to two months after a long shipment from Australia (4 plus weeks of travel from farm gate to farm gate in Indonesia).

Fresh green feed for newly arrived stock

Nutrition

New bulls should be fed fresh green chop or on good pasture while supplements will help them recover body condition lost during transit.

Feedlot bulls will require a slower transition from their high-energy high-protein ration.

Train bulls to accept individual supplementary feed – this will provide breeding bulls with adequate nutrition to keep working while still maintaining strength and body condition. A suitable supplement mix could contain 1–2 kg of soybean meal, rice bran, onggok, rice or corn and molasses.

Bulls with a heavy mating workload need to be fed 3% of body weight DM in order to have any chance of maintaining their BCS.

Handling bulls

Never trust new bulls up close as they have been agitated and will be easily annoyed.

Bulls from a feedlot from a high protein and energy ration will tend to be more active and aggressive than the grass-fed bulls.

Aggressive bulls

If a bull is aggressive and dangerous, do not continue to work with it. Bring in other cattle and leave them alone for some time.

If it continues to be aggressive over a long period, consider culling it.

New cattle being trained to electric fencing in the yard

Use portable panels or plenty of bamboo rails to guide the animals; hessian covering will reduce the sight of strange objects or other animals. New cattle will not understand electric fencing until they have been trained and it should not be used.

Upset bulls should be mixed with other cattle until they quieten.

Electric fence training

After 3–4 days, begin their electric fence training in one of the larger outside yards.

Give them plenty of room to experience the fence, then slowly move it a bit closer each day until they are in a relatively small area and can understand what the electric wire means.

Use some sort of bedding in a hard yard during the start of the training to reduce the chances of them slipping.

Make sure feed and water are available in the training area.

Introduction to cow herd

Newly arrived animals have to be well rested and allowed to adapt to the local environment before they join the herd.

After adequate rest and at least 1 week of electric fence training, the new bulls will be ready to be introduced to the cows that should be brought in the yard.

There must be no other existing bulls in the group as they would fight.

Leave bulls and cows in the yard for 2–3 hours before taking the whole group back out to the grazing area. By this time they should be interested to stay with the cows and also understand and respect the electric fence.

2.2. Transportation of cattle

Comprehensive information on the transportation of cattle to and in Indonesia has been compiled in ***Best practice guide for the transport of cattle in Indonesia***. The guide is available in both English and Bahasa Indonesia languages.

This guide covers:

1. Planning and sourcing cattle

- Timeline for undertaking sourcing, procurement and transport planning activities
- Work instruction: Source and consolidate animals appropriately

2. Pre-transport preparation

- Journey and contingency plan template
- Feed and water curfews and rest stops
- Transport facility, vehicle and vessel checklist

3. Transport infrastructure and facility design

- Example transport facility designs
- Work instruction: Wash down for livestock transport vehicles

4. Handling

- Work instruction: Handling livestock
- Work instruction: Handling escaped animals
- Standard operating procedures for humane emergency destruction
- Work instruction: Humane emergency destruction using stunning
- Work instruction: Humane emergency destruction using a firearm
- Work instruction: Humane emergency destruction using the throat cut method

5. Selecting cattle for loading

- Fit to load checklist

6. Loading

- Work instruction: Inspecting vehicles and transport equipment
- Loading densities guide
- Work instruction: Handling livestock during loading
- Loading checklist

7. In-transit management

- Standard operating procedures for breakdowns and emergencies

8. Discharge and unloading

- Receival and unloading checklist
- Work instruction: Handling livestock during unloading

For the complete guide, see:
http://www.redmeatcattlepartnership.org/media/1ZQt0-best-practice-guide-for-the-transport-of-cattle-in-indonesia.pdf

Non-slip flooring covered with bedding – and some green feed to keep cattle calm

Stock density – enough for animals to support each other as the truck moves

IACCB Case Study: Safe transportation of breeding cattle from Australia to remote locations in Indonesia – steps to achieving a high success rate.

As part of establishing the IACCB program in 2016/17, the team was required to transport 1,200 heifers and 113 bulls to remote locations in South Kalimantan, Central Kalimantan, Lampung, Bengkulu and East Java. This task was achieved with no losses of cattle due to a good knowledge of potential risks, combined with careful planning to reduce or avoid these risks. Careful planning included:

- Truck set-up – all trucks had a non-slip floor covered with sawdust or other bedding to reduce the risk of slipping
- Density of cattle in trucks – reduced from 12 to 10 head per truck to avoid the risk of cattle going down during transport
- Timing - transport was done during night to reduce heat stress and fatigue
- Feed availability – feed was provided to cattle every 6 to 8 hours on truck
- Rest – where journeys were longer than one full day, cattle were removed from the truck into a kandang and fed grass and water and rested for 24 hours
- Cattle selection – no cattle were transported if they were heavily pregnant (more than 6 months), sick, injured, severely lame, blind, weak or emaciated and unable to keep up with the mob. Where long and stressful transportation was required, only dry cattle were selected.

Problems with cattle transportation occur when:

- Transportation involves travel in excess of one day by road and/ or sea.
- Cattle trucks are over-crowded and are not regularly checked for cattle going down.
- Cattle trucks are poorly fitted out – inadequate non-slip floors and loading ramps, low sides, etc.
- Cattle are not properly rested. For long journeys, this requires them to be removed from the truck for feed and water. Thus kandangs that can be used at appropriate locations enroute have to be identified before travel.
- Cattle are more than six months pregnant, use reliable pregnancy diagnosis.
- Appropriate feed and water is not provided.
- Cattle are transported through the heat of the day and are not rested appropriately.
- Insufficient planning is carried out. This includes a thorough risk identification process.

2.3. Ruminant nutrition

2.3.1. Introduction

Cattle resting, and chewing their cud, generally indicates that they have enough to eat.

Cattle are ruminants, able to digest grass through the activity of microflora in their complex digestive system. However new-born calves act more as monogastric animals, with an efficient simple stomach, while they rely on highly nutritious milk.

After a few weeks, the microflora in the calf's rumen begins to develop so that the calf can start to digest grass. This process of rumen development calf governs the type and quantity of feed that a calf needs for good growth.

The need for an energy or protein supplement for a calf, yearling or adult will depend on the quality of the grass in the diet, and whether the aim is to gain weight, maintain the animal's condition or to minimise its weight loss. The amount and type of supplement to be fed depends on the nutrients needed and on the economics – supplements being more expensive than grass.

A mature cow will eat this amount (40–50kg) of green feed each day

How much can a ruminant eat?

The amount of feed that an animal can eat is governed by the rate that the feed can be digested in the rumen and passed on through the digestive system. With good quality feeds, cattle can consume about 3% of their bodyweight in feeds (on a dry weight basis). So a cow weighing 400 kg will eat 12 kg of dry feed or around 50–60 kg of fresh, high quality forage. (Forages generally contain 20–25% dry matter)

2.3.2. Basic nutritional requirements

All cattle need energy, protein, water, minerals and vitamins, with energy and protein the most critical for growth but the diet must be balanced. Under the rule of limiting factors, there is little point in supplying large quantities of energy if there is insufficient protein in the diet for the rumen microorganisms.

Adequate clean water is essential

Water

Water is not a nutrient but is vitally important for all body functions. Feed intake and water intake are linked so that adequate, clean, fresh water must be provided.

Energy

The main sources of energy are sugars, starches and fats.

Energy is typically expressed as MegaJoules of Metabolisable Energy or MJ ME. Metabolisable energy is the energy in a feed that is actually available to the animal to use for maintenance, growth, lactation and pregnancy. For example, coarse mature grass will have a high gross energy content, but much of this will be unavailable because it is indigestible fibre. In contrast, the energy content of copra meal is highly digestible.

Fibre

The ruminant can digest some plant fibre. It can convert low-quality fibrous grass (that few other animals can digest) into high-quality protein.

Fibre is the structural carbohydrate in plant cell walls. Fibre consists of both digestible (hemi-cellulose) and comparatively indigestible fractions (cellulose and lignin). All plant feed contains fibre but it varies in digestibility.

Leaf is more nutritious than stem, it is digested faster and the animal can eat more. Forage fed to young animals should contain more leaf than coarse stem and is best chopped to a length of 2.5–3 cm. If the leaf is too long and stemmy, the animal must chew more to break it up, it also decreases feed intake because it is retained longer in the rumen.

Harvest fresh young regrowth every 50–60 days for penned stock.

Old king grass with heavy fibrous stems is a poor quality feed and should not be fed to calves or weaners.

Protein

Protein for ruminants can be derived from two sources of nitrogen; true (organic) protein from forages, grains and protein meals, and Non-Protein-Nitrogen (NPN) from inorganic compounds such as urea.

Irrespective of the source of nitrogen, rumen microorganisms breakdown protein to ammonia that they then combine with energy sources for their own growth and reproduction. Protein that is broken down in the rumen is referred to as rumen-degraded protein (RDP), while protein that escapes breakdown in the rumen is called bypass protein or undegraded protein (UDP).

The microorganisms themselves pass out of the rumen and their own high-quality protein is broken down in the abomasum and small intestines into amino acids that are absorbed into the animal's body. These microorganisms are a major source of high-quality protein to the animal.

The bypass protein is also digested in the abomasum and small intestine—more efficiently than in the rumen. Some legumes contain bypass protein and this often accounts for their high feed value.

Nitrogen deficiency in the diet reduces production of microbial protein which, in turn, will decrease rumen efficiency, and hence feed intake. As little metabolisable protein is stored in the body, it must be fed continuously to be available.

Minerals

The animal uses minerals mainly for structural purposes, such as bones, and as catalysts for enzymatic reactions. In most tropical pastures in the high rainfall zone, minerals, such as phosphorus, sulphur and sodium, are deficient and are required in considerable quantities. Trace elements include cobalt, copper, manganese, selenium, iodine, zinc and iron, are required in comparatively small amounts, and possible deficiencies have not been recognised yet in this region.

Minerals and vitamins

Grazing animals normally get their vitamins from their diet or from their rumen microorganisms. Water-soluble vitamins, such as those in the B group, are replenished regularly from green feed, but fat-soluble vitamins (A, D and E) can be stored in the body's fat.

See Section 2.9 – Energy and protein rations for suggested mineral mixes.

Nutrition and the calf

At birth, the rumen of the calf is smaller than the abomasum because the calf will be digesting only milk. This milk passes directly through the rumen, along an 'oesophageal groove', into the abomasum for the most efficient digestion.

Insuffient feed trough space encourages bullying of smaller animals

The rumen and reticulum start to develop when the calf eats fibrous feed, with the rumen microorganisms coming from adult cattle with which it is grazing. Under normal paddock conditions, the rumen will be fully functioning by the time the calf is three months old.

Until the calf is weaned, nutrient-rich milk, even in small quantities, supplies the best of the calf's nutrition.

Once the calf is weaned, its rumen expands quickly but the grazing weaner has to obtain all of its nutrients from a diet high in roughage.

From milk to protein and energy supplements

The mix of the various types of microorganisms present in the rumen depends on the animal's diet. In grazing cattle, the microorganisms are mainly those adapted to breaking down plant fibre; in cattle on grain diets, the microorganisms are mainly those that use starch.

If weaners are going from pasture to grain feeding in the weaning yard, diet changes must be made slowly so that the numbers and types of microorganisms have time to adjust. A rapid change from a fibre to a solely high-starch diet can result in animal acidosis, a digestive disturbance which may cause severe metabolic disorder or even sudden death.

Will the calf eat all of it?

Placing what appears to be sufficient supplement in front of a young calf is not enough, it has to be physically able to eat that amount of feed, and this will depend on the quality of the supplement.

Maintaining enough effective fibre in the diet stimulates chewing of the cud, this promotes saliva production which buffers excessive acidity of the rumen.

Feed intake is often expressed as the weight of moisture-free base (dry matter) eaten as a percentage of the animal's liveweight.

Legumes such as Indigofera provide high protein feed.

Voluntary feed intake ranges from as low as 1–1.5% of liveweight for animals on very poor quality feed such as mature dry pasture and up to 3% on high-quality feed such as a feedlot ration.

Voluntary intake is governed by the physiological size of the rumen and the rate that the feed is digested in the rumen. The animal can only eat more when the food already in its digestive system has passed through; thus feed intake is directly proportional to the energy density (digestibility) of the feed being eaten. Factors such as health and palatability can also affect intake.

The desired weight gain

A 100 kg weaner can eat no more than about 3 kg of dry matter per day. For it to gain the desired 0.5 kg per day, all the feed offered must be of high quality and very palatable.

2.3.3. Feed quality

The most important aspects of the grazing ruminant's diet are protein and energy. Protein in the diet is used to build protein in the body for muscle, and energy for basic metabolic function and to drive the muscles. Both are used in large amounts for reproduction and lactation.

Too little of either will reduce the rate of live weight gain, the ability to recover body weight after giving birth to a calf and will reduce milk supply for the calf.

The grazing animal has to get its basic need for protein and energy from herbage – mainly grass but also other plants, be they legumes or palm fronds.

The amount of protein and energy in a pasture will depend on:

- the species – grass, legumes, herbage
- the stage of growth (plant maturity)
- the nitrogen in the soil
- the amount of sunlight reaching the ground – shade levels.

Species. Some details about different pasture species are given in the section on species. Legumes are especially valuable because they manufacture protein through the nodules on their roots. They provide quality but less quantity because the nodule bacteria use some of the plants' energy to manufacture (fix) protein from atmospheric nitrogen.

Stage of growth. New leaf has the highest level of protein and energy because the plant's cell walls are easily digested and have not yet lignified. The total production of leaf from a grass plant accumulates quickly with time but then falls off as old leaves age and die. Senescence can be strongly influenced by season as soil moisture becomes limiting.

Nitrogen in the soil. This is a major driver for feed quality and quantity. Newly disturbed soil has the highest levels of nitrogen as soil organic matter breaks down, but nitrogen levels drop very quickly under conditions of high temperatures and high moisture – as in the wet tropics.

Shade level. Pasture growth declines quickly as shade increases. See Section 3.1 Pastures for more information.

Diet preferences

The feed available in a pasture may be altered by preferences of the grazing animal. Animals prefer some plants or stages of growth and seek these out first; this allows the animal to select a better diet than expected from a first look at a pasture.

Cattle also have taste buds; they find some species less palatable and, if they have the choice, will not eat them unless forced to. We recognise totally unpalatable plants as 'weeds'. Other plants may have levels of substances that may upset the body. Eating too much of some species can cause problems such as abortions, bone formation or digestion.

T-grass (Paspalum conjugatum) is not highly nutritious but is often found in shade under palms.

Tall grass, like this Pennisetum polystachyon, has low nutritional value and is unpalatable when mature.

Poor grass species and growth under high shade.

Cattle often prefer grass growing more vigorously on the roadsides.

Phosphorus supplement is often fed mixed in hard salt blocks. Always check for a minimum content of 5% phosphorus.

NPK fertiliser is applied for pasture establishment – and to improve quality and yield of existing pastures where there is an economic response.

If the grazing animal cannot select the diet that it prefers, it will not gain weight or reproduce as well as it could, and will not meet its genetic potential.

When stock are forced to graze a paddock or pasture block heavily by using high stocking rates with fast rotations, their potential cannot be reached. This can occur when cattle are used as grass mowers to keep vegetation levels low to aid harvesting of the plantation's primary source of income.

Cattle grazing under oil palms are frequently observed to preferentially graze the open areas along fences or roadsides where the pasture is more nutritious.

2.3.4. Mineral deficiencies

Phosphorus

Another aspect of pasture quality resides in its mineral content. Besides having low levels of nitrogen, many soils in high-rainfall areas of the tropics have low levels of phosphorus and this phosphorus may not be available to the plant because it is locked up chemically by the soil's acidity (low pH).

Cattle need phosphorus for almost every vital function of the body. It is used for building bones and teeth, metabolising fat, carbohydrates and protein, producing milk and for efficient feed utilisation. A phosphorus-deficient animal will eat less pasture. It suffers from poor appetite and feed intake, poor growth, high breeder mortality, reduced fertility and milk production and bone breakage.

Breeding cows need 8–10g P per day, growing animals 4–6g P/day.

Phosphorus can be provided as a supplement generally in the forms of blocks or as loose mineral mixes. Hard rainfall-tolerant blocks are made with salt that sodium-deficient animals relish. However, many locally available blocks have very low P content so this should be checked when ordering. Blocks should contain 5–8% P (with a minimum of 5%). Loose mineral mixes are made more cheaply on the farm but have to be fed at 100–150 g/head/day in troughs protected from rainfall.

See Mineral Mix 3 in Section 2.9 Energy and protein rations.

Improving pasture quantity and quality

Another way to improve pasture quantity and quality is to apply nitrogen and phosphorus to a deficient pasture as fertiliser. Indeed fertiliser is applied to oil palms regularly to promote their growth and yield because it has been proven to be economical. Current practice is to apply the fertiliser around the base of the palm and under the line of pruned fronds. However, it may be more effective to both palm and pasture to spread the fertiliser over the whole area where the palm root system extends. Note that cattle are forced to eat palm fronds where there is insufficient pasture.

There have been few trials to ascertain the profitability of applying extra fertiliser to pasture in Indonesia. Profitability would depend on the cost of fertiliser, the levels applied, the value of the output from the cattle herd and hence on the stocking rate (the number of stock per unit area fertilised).

In Australia, phosphorus is supplied directly to cattle as a supplement once the stocking rate exceed about 3-4 animals per hectare, and as a part of standard animal management in low-phosphorus country. At higher stocking rates under more rainfall, fertiliser is applied to the whole pasture area.

Freshness and storage of supplementary feed

Any energy or protein supplement fed must be fresh. Hot and wet chop is readily eaten but not if it is mouldy as can happen quickly in the humid tropics. Most mouldy feed is not relished and so will restrict intake and hence animal production; they can also produce toxic mycotoxins. Fresh feed is particularly important in breeding herds.

Supplements must be fed fresh each day as they are quickly spoiled by rainfall.

2.3.5. Lactation anoestrus

Bos indicus cows often do not show ovarian cycling while lactating – this is called lactation anoestrus. Thus it can be difficult to get the cow to reconceive for some months after calving. European (*Bos taurus*) breeds do not show a high level of lactation anoestrus as *Bos indicus* breeds.

However, there is some variation in the level of lactation anoestrus in *Bos indicus* cows as some will readily reconceive within three months after calving. This feature is being selected for by progressive breeders.

Overall, a cow's poor body condition can be a major reason for failure to cycle, and thus having a BCS of 3.5 or above at calving is an important management target.

Early weaning will help; cows weaned in medium to-good condition should resume ovarian cycles within about 50 days.

Cattle chasing the tractor indicates their desire for supplements.

Brahman cows often will not show oestrus cycling while lactating – especially when body condition is low.

2.4. Bull management

2.4.1. Selecting breeds

The breed must be suited to the tropical environment under oil palm plantations typified by very high rainfall and high humidity. External parasites are also a significant challenge.

IACCB experiences

Some experiences with introduction of stock in the IACCB program are described.

Some problems experienced with imported bulls

- Imported bulls generally arrive later than the ideal time in herd management.
- The bulls are frequently stressed after their long journeys, sometimes exacerbated by coinciding with severe monsoonal conditions.
- This stress of relocation may result in bulls being infertile for up to three or more months.
- Some imported bulls are too young (around two years) and too light to immediately withstand a heavy mating work load. (Ideal bulls are 3 years old and over 500 kg liveweight)
- Supplementary feeding of bulls in the paddock can soon improve their BCS and virility.
- The overall effects of these factors is that pregnancies are often significantly delayed, resulting in low conception rates, bull wastage and ultimately financial losses.
- Many local stock handlers are unfamiliar with the need to manage the stress and nutrition status of new bulls
- Purchasing local bulls from feedlots as an emergency contingency plan is an option but is expensive and can have somewhat unpredictable results. Careful management of these feedlot bulls is essential to ensure that they are suitable for serving cows either in the yard or under grazing conditions. Feedlot bulls can quickly lose body condition and virility under grazing conditions and heavy workloads.

SOP for arrival of new bulls

The following comments and recommended Standard Operating Procedures are for the receival, delivery and adaption of imported and local bulls.

Staff training

Train new managers and stockmen in low-stress handling methods and the potential dangers posed by large bulls.

Trucking

Standard ESCAS rules must be observed; animals must be checked every hour, the truck deck must be non-slip with steel mesh and covered with sawdust or straw, there should be no protrusions and the tailgate must be firm and stable. The truck tyres should be in good condition with adequate tread.

If cattle are trucked over long distances for 12 or more hours, try to organize a rest stop with dry, clean pens and adequate clean water and fresh green chop.

For more detailed information see:
http://www.redmeatcattlepartnership.org/media/1ZQt0-best-practice-guide-for-the-transport-of-cattle-in-indonesia.pdf

Tagging and checking ears of new cattle for NLIS tags and for absence of HGP implants

First arrival

When the bulls first arrive off the truck they will be tired and weak. Unload off the truck as smoothly and quietly as possible to reduce their stress.

a. Ramps and truck tailgates should be checked for animal safety as per ESCAS standards.
b. Spread plenty of sawdust, sand, coconut husk or bagasse on the ramps.
c. Make sure there are no protrusions on the side rails and gates.
d. Reduce noise as the bulls are unloaded and avoid having too many people around.

Handling

Work quietly and slowly with patience when handling bulls.

Stressed bulls will present a risk to their handlers and to themselves if they slip or crash into fences.

Never trust new bulls up close as they have been agitated and will be easily annoyed.

Bulls from a feedlot with a high protein and energy ration are often more active and aggressive than grass-fed bulls.

Use portable panels or plenty of bamboo rails to guide the animals; hessian covering will reduce the sight of strange objects or other animals. New cattle will not understand electric fencing until they have been trained so do not use it.

KEY POINT – If a bull is aggressive and dangerous, do not continue to work with it. Bring in other cattle and leave them alone for some time. If the bull continues to be aggressive for a long time, consider culling it.

Aggressive nature, as a genetic trait, is undesirable in your future herd.

Pens

A large secure yard is preferable but allow plenty of pen space (with a minimum of 6 m^2/hd). The yard should not become too boggy during heavy rain.

Do not mix new bulls with any other stock on arrival, they must stay on their own until they are ready to join the cows.

A roof or shelter may not be needed unless the new bulls arrive under heavy rainfall in the monsoon.

Spread good dry bedding over the concrete so that they can rest comfortably and recover from their long journey.

Rest

Depending on the length of the journey, bulls need significant rest before their semen will be of a desired quality.

Minimum rest for a short journey (1 day) is 1 week, but allow up to three months after a long shipment from Australia (4 plus weeks of travel from farm gate to farm gate in Indonesia).

Nutrition

New bulls should be fed fresh green chop or be on good pasture. Supplements will help them recover body condition lost during transit.

Bulls should be fed 3% of body weight as dry matter (DM).

Feedlot bulls need a gradual change from their high-energy, high-protein ration to pasture.

Electric fence training

Electric fence training

After 3–4 days, begin their electric fence training in one of the larger outside yards.

Give them plenty of room to experience the fence, then slowly move it a bit closer each day until they are in a relatively small area and can understand what the electric wire means.

Use some sort of bedding in a hard yard during the start of the training to reduce the chances of them slipping.

Make sure feed and water are available in the training area.

Introduction to cow herd

After adequate rest and at least 1 week of electric fence training, the new bulls will be ready to be introduced to the cows that should be brought in the yard.

There must be no other existing bulls in the group as they would fight.

Leave bulls and cows in the yard for 2–3 hours before taking the whole group back out to the grazing area. By this time they should be interested to stay with the cows and also understand and respect the electric fence.

Provide effective protection against biting insects and ticks.

Health

Provide effective protection from biting insects and other pests and parasites.

The simplest method is to treat them every 3 to 4 weeks with a pour-on parasite treatment. This can easily be sprayed on each bull as they move from cell to cell during the daily relocation. Bulls will attract more flies so they will usually require more frequent treatments than the cow herd. Treat any illness or injury promptly. If the animals are far from a yard, a pole syringe can be used to deliver injections in the field.

Where possible, separate a sick bull from the group and place it in a rest or isolation pen.

If there is any doubt about the problem, send photos and description to a veterinarian by Whatsapp for advice.

The main problems are likely to be injuries from the truck trip or from falling over in the yards. In these cases, antibiotics and anti-inflammatory injections (Exfo and Flunixin) will most likely be the best treatment.

It is best to treat a bull in the crush but the pole syringe can be effective in the yard. Take the temperature of any sick bull if it is brought to the crush.

Local bulls can drop their body weight rapidly when introduced to a large number of cycling cows.

Local bulls

As imported Australian bulls are likely to remain stressed and infertile for at least 10 weeks, local bulls could be used where pregnancies are urgently required.

Local bulls will be of unknown genetic quality and generally vary greatly in their performance and in the quality of their progeny. Overall, Australia bulls with known fertility and production traits will be of significantly higher quality.

Local bulls may also suffer some relocation stress. They need to become adapted to the release of their nose ropes, along with strengthening their body and legs for the new-found ability to mount. Vigorous mating activity combined with a dramatic reduction in nutrition while grazing will usually result in rapid weight loss.

If in doubt about any aspect of the bull management, ask the advisor team via Whatsapp or by direct hand phone call.

Bull in good condition for working (BCS 3+)

2.4.2 Nutrition

Working bulls

Working bulls need a higher quality supplement to maintain their vigour than that provided to the grazing herd to maintain body condition.

A higher quality supplement mix could contain 1–2 kg of soybean meal, rice bran, onggok, rice or corn and molasses.

The recommendation is to give the mix below to each bull once per day (any time)

1.5kg gaplek or onggok; 1.5kg Bungkil sawit; 0.5 kg sludge/solids

Mix these three ingredients in a small bucket and feed one bucket to each bull every day (until their Body Condition Score (BCS) is 3+)

Track their BCS regularly to pick up any decline early so that remedial supplementation can be provided.

If they do not improve enough, increase the onggok and the bungkil at a later time (2 kg each).

Under the cell grazing system used for sawit integration, targeted supplementation can be fed to working bulls daily. They soon become conditioned to a regular supplement fed in the same way each day.

See Section 2.9 for supplement ration for bulls.

Bulls can soon be trained to eat dedicated special mix supplements.

2.4.3 Injuries, ailments and treatments

See Section 2.8. Health problems and treatment.

2.4.4 Bull behaviour in the herd

Check for signs that a bull is actively working by observing signs of heat in cows. Every day observe for signs of mounting e.g. mud on flanks, ruffled tail coat.

Libido is not usually a problem unless the bull is lame, sick or aged.

A common complaint from local stockmen is that they never see Brahman bulls mate and therefore they assume that they are infertile and not working. Proof via normal pregnancy rates confirms that Brahman bulls rarely mate during the day time and prefer to mate only at night. This is a natural trait which we assume has been developed to reduce heat stress.

Local bulls with horns may dominate with newly imported hornless bulls and should not be mixed with them.

Dominance

Introducing a number of new bulls together has to allow for time to establish a 'pecking' order.

Local bulls (or cows) with horns should not be mixed with the newly arrived Australian bulls, which are generally dehorned. Even small young bulls with sharp horns can injure a much larger bull with no horns, and can keep this larger bull away from cycling cows.

Bull handling

Cattle from extensive herds in northern Australia often receive little handling in the paddock; their main training is done by 'tailing' (daily riding weaners out of yard into paddocks under the control of stockmen on horses) and handling at weaning.

Brahman cross breeds are intelligent. They can soon become quiet with regular careful handling and some hand feeding – but can be aggressive if upset.

- Do not make unexpected rapid movement from behind a bull where it cannot see you. Work from the side using a 'cattle talker' (flexible goad with plastic head).
- Do not have a lot of workers making unusual noise next to the yard.

A cattle talker for quiet handling

Bulls are herd animals and may not like being kept solitary.

Always be wary of a solitary bull in a yard – it is nervous, may become aggressive and try to jump the railings, crash gates or charge handlers. (Some yards have narrow vertical gaps in the rails to allow stockmen to escape attacking bulls.)

Upset bulls should be mixed with other cattle until they quieten.

Bulls will try to jump fences or push over electric fences to return to a herd or to chase a cow on heat. Brahman cross bulls are agile and can jump 1.5 m high railing with ease.

2.4.5. Culling bulls

Keep a working bull for about seven years, which is until about 9 years of age, unless it is ailing, has low libido, is being dominated by younger bulls or could be mating with offspring or close relations. Every time the bull passes through the yard it should be checked for any general problems and should also have its testicles palpated. Stockmen have been trained to conduct a simple palpation of the testicles to check for size and consistency. If the testicles have shrunk or are too soft or have developed some other abnormality the bull should be removed from the herd for a veterinary check.

Persistently aggressive bulls should be culled because their progeny are likely also to be more aggressive.

While keeping a bull for longer will reduce the cost of replacement, new bulls might be genetically superior. However, check whether the limitation in herd performance is due to genetics or nutrition.

Taking a semen sample from a bull to check fertility

2.4.6. Bull exclusion for seasonal mating

There may not be a strong reason for restricting births during the rainy season where calves can gain protection from the weather under roofed areas in breedlots or in creep stalls.

However with grazing cattle it is definitely desirable to restrict mating to prevent calves being born during the peak of the rainy season. This peak is generally during December, January and February, but may vary slightly between different parts of Indonesia

In this case, bulls should be removed from the breeding cows during the months of March, April and May – determine the months that are likely to be most stressful in your location and work back 9.5 months from those months to determine the exclusion period required.

This also gives the bulls a chance to regain their body condition and give their reproductive organs a rest.

Checking bull's scrotal circumference for breeding soundness

2.4.7 Mating

Weaning rate is perhaps the most critical factor of the productivity KPIs. This is a function of conception rate less abortions, still births and calf mortalities. The key driver of weaning rate is the conception rate (% cows pregnant v total cows) over a given period of time, normally 1 year.

AI or natural joining?

In a commercial grazing system, and more so the SISKA breeding model, Artificial insemination (AI) is impractical without daily access to the cows. Signs of heat need to be detected twice daily or the cow herd needs to be synchronized for oestrus.

As both activities require intense management with uncertain outcomes, natural mating with bulls is highly recommended.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2.5. Cow and calf management

2.5.1. Breeder management

Under the SISKA system, the breeding herd (cows and bulls) is moved daily to a new block of grazing. This gives the herdsman the opportunity to check the herd each day and to identify existing or potential problems with any bulls, cows or calves. Suspect animals may be treated and possibly drafted in a temporary set of moveable yards.

Every 60–90 days, the whole herd will be mustered into the central permanent, more substantial, yards where cattle can be drafted into secure pens or treated in a race. Bulls may be removed to prevent calving during the wettest and hottest months and calves of suitable age or weight can be separated and weaned.

2.5.2. Mating

Mating

Signs of a cow cycling – muddy flank and scuffed hair at the top of the tail indicate that either a bull or another cow has been riding

Joining in grazing herds is only feasible using natural mating. Bulls are run with the cows and mature heifers at a ratio of about 5% - one bull to 20 females. Although 3% is a normal ratio for commercial beef production in Australia, the higher ratio is recommended under the SISKA system because of problems when new bulls are relocated into the more stressful climate and because of poorer visibility of the cow herd under the oil palm plantation. Bulls can be removed between March and May to avoid calving during the peak of the wet season (December, January and February) to reduce the risk of fly myasis and pneumonia in newly born calves. Restricting calving during the peak rainy season is also sensible where cattle are held permanently in yards as calves will struggle in boggy conditions.

Newly imported bulls and heifers need time to acclimatise to the local environment before being mated.

Strict seasonal mating for a three-month period – as occurs in northern Australia – is not necessary in environments where pasture growth is fairly even throughout the year and low labour costs allow more intensive management, but bulls may be removed to prevent calving during the hottest and wettest months. Also a regular small supply of calves for weaning reduces the need for large infrastructure in yards.

The cell grazing system in oil palm plantations allows the herd to be mustered and checked every day. If required, the herd can be run through a drafting yard that allows animals to be selected and drafted for special management. Portable drafting races are available for use in the plantation when the cattle are a long way from the permanent drafting yard. Poor condition, lactating cows can be drafted for additional supplement or feeding on better pastures while their calves could be removed for weaning.

In the SISKA system where the herd is run on low quality pastures under the palms, a recommendation to wean calves at about 80kg at 3 months of age is being amended to wean later (4–6 months) because of the cost of special supplementary feed.

On open and improved pasture, older calves in good condition can be weaned at 4 to 6 months at a weight of over 100kg.

See Section 2.9 Appendix for energy and protein rations for pregnant (Table 7), lactating (Table 8) and empty cattle (Table 9).

Calving intervals

The goal of a breeding operation is to produce a calf every 12 months – 9 months of gestation (mating to calving) followed by 3 months of lactation for the small calf, and then reconception. To achieve this, the cow must be able to attain a Body Condition Score (BCS) of 3.5 before mating. This is difficult to achieve with Brahman-cross cows on low quality or quantity of pasture. Given that lactating cows do not readily recover BCS, the strategy to achieve the desired BCS of 3.5 at the time of joining needs to start before calving.

Supplementary feeding the cow and early weaning the calf at 3 months help to improve body condition but at a cost. It is cheaper to feed a small calf than to feed an adult cow.

When grazing pasture of only moderate quality and in environments where there is little or no dry season, it may be more practical and economical to produce a calf every 18 months (i.e. 2 calves in 3 years). This issue needs to be determined for each enterprise, taking into account the cost of feeding and managing cows in comparison to the value of additional calves produced.

It is especially difficult for first-calf cows to reconceive within 12 months as newly-calved heifers need longer to recover body condition.

Breeding stock in reasonable condition – bull is BCS 4, cows BCS 2+.

Breeding cows in poor condition (BSC 1). These cows were in poor condition before calving, mother and calf may not survive without supplementary feed. This calf is too young to wean now.

Lactation anoestrus will prevent this cow from reconceiving while she is lactating.

Lactation anoestrus

Bos indicus cows often do not cycle while lactating for hormonal reasons – this is called lactation anoestrus. Thus it is difficult to get the cow to reconceive for some months after calving. European (*Bos taurus*) breeds do not show a high level of lactation anoestrus, and will often begin cycling while lactating.

While some Brahman cows often show a level of lactation anoestrus, others will readily reconceive within three months after calving. Selection and breeding is likely to gradually reduce the level of lactation anoestrus in *Bos indicus* breeds.

Overall, a cow's poor body condition can be a major reason for failure to cycle, and this having a BCS of 3.5 or above at calving is an important management target.

Lactating cows

Lactating females need plenty of protein, energy and minerals. Most milk production must come from the cow's diet but much is from body reserves.

Feed quantity and quality should be highest when the growing calf's demand for milk is greatest at 2 to 3 months of age.

Cattle managers need to understand the seasonality of their pasture growth and quality on their land type. This will enable them to tailor a supplementation strategy at least cost.

If the pasture is insufficient in quantity or quality, the cow and calf will suffer – the cow will become too thin to reconceive and the existing calf will grow poorly.

Two management options to overcome feed deficiency from pasture::

- provide medium quality supplements to both grazing cow and calf
- wean the calf and feed it an extra high protein diet.

This decision must be based on economics.

Phosphorus supplements should be available throughout the year so that the lactating cow does not deplete the phosphorus in her bones excessively. Phosphorus can be supplied through a salt block or as a component of a supplementary ration. Experience is showing that cattle being fed concentrate are getting adequate supplementary P.

2.5.3. Calf management

For stress-free calving

Pre-calving – It is beneficial to prevent calving during the peak of the hot wet weather by removing bulls 9 months before this. Cows, and especially heifers, that are not in adequate condition could be fed supplement for 90 days before calving.

Cow behaviour – the pregnant cow will show signs in the week, days and hours before calving. Her udder will begin to fill, she may try to separate from the rest of the herd and her vulva may show a discharge.

Facilities – in the case of cows managed in a yard, heavily pregnant cows should be separated from their pen mates into a calving pen to allow closer supervision and to reduce unnecessary handling of the very

young calf. Shelter against heavy rainfall or excessive heat is essential during the peak monsoon conditions.

Calving

Record keeping – the date of calving, along with any unusual behaviour should be recorded by the stockman. The stockman should ensure that the calf is born alive – see section on calving - and check and record its health over the first 4 weeks.

The calf mortality rate is a Key Performance Indicator (KPI) for a breeding enterprise. Reasons for high mortality must be investigated by a veterinarian.

Calf treatments

All calves should be checked to ensure that they receive colostrum from their mother during the first 3-6 hours after birth. If there is any doubt, the cow should be hand-milked and colostrum fed to the calf with a bottle or stomach tube. Calves should be checked and treated for screw worm infection of the navel after birth.

Ear tagging – Calves should be ear-tagged at weaning time (early weaning or late weaning) and the wound checked for screw worm under hot and humid conditions.

Castration – Bull calves do not need to be castrated because of the local preference for entire animals.

Dehorning – Calves should be dehorned where the appropriate equipment and skills are available. Care must be taken to reduce the risk of the wound being struck by screw worm fly.

When to dehorn

Calves are less stressed if dehorned when young as the operation is less traumatic and they can return to their mothers; small calves are also easier to handle.

The horn bud attaches to the skull at around 2 months of age so dehorning before attachment results in less bleeding and trauma to the surrounding tissues. At this stage, dehorning can be done with a sharp knife or with hot-iron cup over the bud in young calves.

In the Indonesian tropical environment, surgical activities including dehorning are best done when the calves can be retained in a clean and dry yard for one to two weeks to ensure that their wounds heal satisfactorily and do not develop bacterial or screw worm infections.

Swollen udders will prevent a young calf from suckling. The cow may have to be culled.

Young calves must be checked regularly for health and growth.

Why dehorn?

Cattle with horns often dominate over hornless stock; even small horned local cattle can scare off valuable hornless imported bulls.

Horns are a danger to stock handlers and also to other cattle. Injuries are common when horned animals are held in yards at high density or are transported by truck. If horned animals are slaughtered shortly after travel, carcases can be bruised and downgraded in value.

Scoop dehorners are used to scoop out the horn bud.

Dehorning equipment

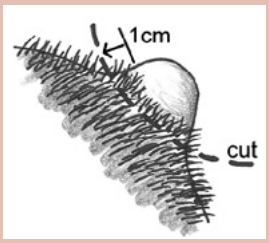
Calves under 2 months of age can be dehorned with a sharp knife but older calves or weaners require a scoop dehorner. Any type of equipment must be clean, sharp and disinfected before and after use.

How to dehorn

First clean and disinfect the area around the horn as well as the dehorning equipment. A larger calf needs to be well restrained before the scoop dehorner is placed over the horn bud so as to cut it out with a small ring (about 1 cm) of hair surrounding the bud to prevent regrowth.

Key to successful dehorning

Because the horn grows from the skin around its base, you must remove or destroy a complete ring of hair (1 cm wide) around the horn base. If this ring is not wide enough, some horn will continue to grow.



Standard treatment for each calf will include

1. Disinfect the dehorning site.
2. Treat the wound site with Gusanex to repel flies. A single injection with Dectomax or other form of ivermectin will continue to kill maggots that infect the wound for up to 3 weeks.
3. Examine for infection and myiasis at least twice daily, and treat as required.

Creep feeding

Calves can be provided with a high-protein supplement while still suckling. Creep feeding allows small calves to 'creep' through narrow posts in a fence without allowing access to the lactating cow. Creep rations are of high quality and both the ration and calves require protection against rain. Experience is suggesting that creep feeding may have only moderate benefits on the weaning weight of the calf or on cow reconception.

See Section 2.6 for more details about weaning.

2.6. Weaning

2.6.1. Why wean?

The calf is taken off its mother to give the cow a better chance of recovering body condition and hence being able to reconceive sooner. Weaning is not for the well-being of a young calf – calves lose their diet of highly nutritious milk at weaning.

As a reasonable balance between reproductive efficiency of the breeding herd and calf survival, IACCB recommends that *Bos indicus* and cross cattle are weaned early when the calves are about 3 months of age and weigh about 80 kg.

Calves weaned before 4 months of age need to be fed a highly nutritious supplement.

These calves of about 80 kg could be weaned but must be fed appropriate supplements. Their mothers, in BCS 2.5 will quickly recover their body condition and commence cycling after these calves are weaned.

Milk replacer is not a luxury – it may be an essential part of a cow–calf operation.

These well-fed calves should be weaned to help their mothers regain body condition

Separating cows and calves

After separation, weaners are preferably transported to another location far enough away that the mothers cannot hear their calves. The weaner area could either be a feedlot for small weaners or a highly secure yard for older calves. Such early weaned calves would be at risk of disease, poor growth or even mortality if they are not provided with a clean and comfortable environment and high-quality nutrition.

Feed supplement to cow with calf or only to calf?

It costs more to feed supplement to a lactating cow of 350-450 kg with a calf than to feed the supplement only to a calf of 80–100 kg.

Weaning conditions for cattle that will be permanently held in a yard are different to those that will be grazing over large areas. Weaners that will always remain in a yard will not need training with electric fencing.

Weaners that will be managed under grazing with electric fencing must be trained to respect the electric fence. This training takes time and must be managed correctly or young animals will learn that they can escape from the electric fencing. Cattle trained in this way will almost always stay well away from the electrified fence – except under some extreme situations. These include when a cow is separated from its calf, when animals are frightened and run, or when bulls are fighting. Weaning should be conducted in very secure yards and both the weaners and

Electric fencing training

Weaners are commonly let out of their yard to graze nearby grass areas and then returned to the yard for additional feeding and security overnight. Once weaners are trained to this routine it can be difficult to make them stay out overnight in an area enclosed only by an electric fence.

Initial training of all cattle (including weaners) to electric fencing involves holding the animals in a secure yard where an electric wire has been placed along the inside of the yard. The animals can safely avoid the wire but get a shock if they contact it. Thus cattle are trained to understand that the electric fence is unpleasant to contact and should be avoided at all times.

their mothers should have overcome the weaning stress before they are separated by only an electric wire. This separation can take up to 2 weeks.

Weaners can be helped to settle down when out grazing by including a number of adult cattle in the mob. Young cattle generally follow the lead of adult stock that have been trained to stay out in the grazing area overnight rather than challenging the electric fence and to find their own way home to the yard. The larger the number of adults, the stronger the urge for weaners to stay with the adult group.

Holding and feeding weaners in the yard is the simplest form of management but it is also the most expensive. Grazing weaners during the daytime with a return to the yard at night is more economical, especially if highly nutritious grass is available within easy walking distance of the holding yards.

Weaners should be grazed in special purpose paddocks of improved pastures.

After weaning, cows will quickly settle down and, within 7-14 days, can be moved away from the yard area without risk of them trying to get back to where they last saw their calves.

A locally constructed creep area with concrete floor lined with soft bedding of fruit bunch fibre waste, good roofing, and troughs for feed and water. Compare with the wet and muddy yard outside.

2.6.2. Weaner management (3–5 months)

Oil palm plantations practice a grazing rotation of 60–90 days. Each time the cattle come back to the central yards, all calves of the selected weaning age or weight can be taken from their mothers.

Weaning age – Whereas cows on reasonable pasture are normally weaned at about six months of age, grazing conditions on infertile soils under oil palms require a different system.

To balance herd reproductive efficiency and calf survival, IACCB recommends weaning early when the calves are about 3 months of age and weigh about 80 kg. These small calves must then be fed a high-quality ration (See Table 4 of Section 2.9. – Energy and protein rations for suggested rations).

This practice allows the cow to regain body condition and become pregnant again sooner. First-calf cows (also called first-calf heifers) will take much longer to recover and to reconceive than more mature cows.

Weaners aged 5-6 months but under 100kg in yard

Feeding young weaners

The weaned calves must be fed a high-quality ration for at least four weeks with unrestricted access to green, palatable forage – and fresh water. The forage can be as chopped green leaf from vigorously growing grasses but without excessive stem and without palm fronds or from grazing.

If grazing pasture or being fed green chop grass, the weaners must also receive a palatable supplement that provides 200g CP/head/day (e.g. 1 kg/day of a supplement containing 20% CP – and no urea). This 200g CP supplement could be from 0.5 kg soybean meal or 1.0 kg copra meal. PKC is unsuitable because intakes would be insufficient.

This supplement is also suitable as a ‘creep mix’ for suckling calves in a breedlot or when housed overnight in the kandang. It is best fed in small amounts at regular intervals to encourage the calves to eat it.

Weaners of 110 kg in yard eating supplements

Some supplements for young calves and for weaners of 4–6 months of age are detailed in the Table 5 of Section 2.9. Energy and Protein rations. Table 4 in Section 2.9 shows concentrate rations for very young calves up to 3 months of age.

As an alternative to, or in addition to, the supplement, the CP intake could be met by supplying legume forage either as green chop or in a grazed pasture. A weaner would need to consume 1–1.25 kg DM legume leaf per day. As this legume leaf is about 75% moisture, the weaner needs to eat 4–5 kg of green leaf (of, for example, *Arachis pintoi*) to meet the target. (Note that the selected legume species should be highly palatable and without excessive tannin.)

After four weeks of being supplemented with either concentrate or legume, the weaners will be ready to make the transition to the weaner or grower grazing herd. Small or unthrifty calves should be held back until they are strong enough to join the main group.

2.6.3.Feeding weaners (4–6 months)

Larger weaners (male and female) are frequently run as part of the grower herd where it is not possible to provide highly specialised rations.

Supplements for weaners of 4-6 months of age are shown in Table 5 of Section 2.9. These supplement have high protein (16% CP DM basis), and should be fed at 1.25% LW daily (1–1.5 kg/day).

Weaner concentrate can be fed:

1. once daily as a supplement to weaners under grazing conditions

2. to weaners held in confinement (pens, breedlot, kandang) along with unrestricted forage (such as King grass or corn stover).

If included in a total mixed ration (TMR), mix 25% concentrate to 75% forage.

If the forage quality is low (e.g. rice straw), increase the daily feeding rate to 1.5% LW (e.g. 30% concentrate to 70% forage).

Legume Indigofera browse about to be chopped for weaner feed.

Note that leaves should be stripped from woody stems.

Training weaners in breedlot systems

One of IACCB's partner projects involves breeders and calves being maintained in a feedlot before the weaners are moved to a SISKA area to reduce post-weaning production costs.

Old local cows were used to train the weaners to graze under the SISKA. This part worked well. However, as the old cows had also been trained to return to the kandang each evening, the weaners followed the cows back to the kandang instead of remaining on pasture under palms. Once the old cows were removed completely the weaners settled down quickly under the palms.

Old cows can quickly teach weaners their own behaviour. If using cows to train weaners make sure the cows are already doing what you want the weaners to do.

2.6.4. Weaner heifers

Weaner heifers should be kept to develop a new mating group and, when they are old and large enough, joined with newly purchased bulls.

Weaner heifers can be safely included with the breeding groups grazing under trees until they reach about 200kg. After this, they should be run as a separate group without any contact with bulls until about 2 years old and with a minimum of 320kg bodyweight for Brahmans and 250kg for local breeds of heifers. Brahman-cross heifers give birth to small calves (averaging around 30 kg) and rarely suffer from dystocia (calving problems).

All heifers mated when too young may have problems calving and then reconceiving.

Table 6 of Section 2.9. Energy and Protein Rations shows supplements for growing heifers or bulls weighing 130–280 kg.

2.7. Heifer management

2.7.1. Heifer management

Brahman-cross heifers should weigh a minimum of 300 kg and preferably 320–340 kg (their critical mating weight or CMW) before being introduced to a bull.

However, light, first-calving cows can lose considerable condition during lactation and generally fail to get back in calf within 12 months unless they can maintain a Body Condition Score (BCS) of 3 or more.

Heifers on poor pasture under older oil palms

Your problem is?

Is your poor calving performance because of poor genes or poor nutrition?

Heifers grazing new pasture between establishing palms

Culling non-performers

A highly productive breeding herd can only be achieved when strict rules on herd performance are planned and implemented.

Typically in a SISKA model, cows are being grazed in a rotation that means a 3-monthly (90 day) visit to the cattle yards for pregnancy checks and other monitoring. This is a practical procedure to undertake in the herd management calendar.

Some low early calving rates

The IACCB heifers were all imported empty and so weaning rates in the first year were low – at just over 30%. However, conception rates met the KPI of 70–75% on most of the projects. Year 2 has seen the weaning improve to above 65% and up to 85%.

Once replacement heifers are available, unproductive cows are culled as a regular practice.

The key reasons for culling:

- Failure to conceive – Conception rates are the most significant KPI in a breeding herd.
- Poor temperament – This will affect herd behaviour and so indirectly fertility and growth rates. Temperamental heifers and cows will often not maintain the ideal BCS of 3+ and they agitate the other cattle. Since poor temperament is generally genetic, aggressive cattle should be culled.
- Age – Older cows should be culled while still in reasonable condition (BCS 2.5 +) so that they are of higher value. Do not wait for them to lose more condition or to die in the paddock. Depending on the situation, cows can be productive to over 10 years of age.
- Uterine prolapse.
- Injured or infected udders – cull cows if the calf that cannot suckle properly cannot grow.
- Poor mothering ability – particularly in cows on the 2nd calf or more.

Hold culls for their calf

Cull cows that are pregnant should be removed from the breeder herd and allowed to calve. They must be isolated from bulls and, if possible, fed on good pasture to gain additional condition and market value. If feed is not available, sell them as soon as possible.

Poor fertility in the genes or in the feed?

Cows that return to pregnancy early are more likely to produce calves that grow faster and heifer calves that will be more fertile.

But since infertility is commonly associated with poor nutrition, retain empty cows and supplement with concentrates to find out whether a better diet will improve reconception. If after 3 months they are not pregnant, cull them.

Productivity and profitability under SISKA

High productivity does not necessarily mean high profitability if the cost of attaining it exceeds the value of the sales.

In addition to cattle sales, grazing under oil palms provides additional benefits to the SISKA system.

Weed control from grazing saves more than IDR 52,000/ha/yr while potentially better nutrient cycling with cattle manure may increase FFB yields by 10–15%.

Weaning percentages have to be increased when cattle are sold young because the value of a cow comes from it producing a calf. Unproductive cows with low calving performance are eating grass that could quickly put valuable weight gain on saleable cattle. Infertile fat cows can be sold but generally have less value per kg LW than younger animals.

However, slightly lower calving rates, for example 66%, could still be the most profitable system if cows or calves do not have to be fed excessive supplements. This calving rate is normal for cows on poorer pastures and with continuous mating.

Minimise supplementary feeds for cows under palms – feed only those that need to recover BCS – once weaners are big enough, get them out of the yard and onto good pasture.

Upgrading local cattle

The Brahman content of local cattle herds can be upgraded to increase their size while retaining their natural adaptability.

Where crossbreeding is used, good records should be kept on the performance of each cow to show how often she has been mated and produced a calf. Cows that do not regularly produce a calf should be culled as they are not profitable.

Herd productivity and expectations

Weaning rates in the whole herd of below 50% result in a declining herd size. Do not expect high productivity from the first year when importing empty heifers. Purchasing a pregnant herd will speed up productivity, and does ensure a fertile herd at purchase.

Herd growth and marketing

The system of turning off young cattle for sale varies greatly between enterprises, and will greatly depend on location – a SISKA operation in Sumatra will have access to a market that Kalimantan does not have.

Supplements are expensive. Feed them only to build up or maintain body condition of breeders.

Cattle may enjoy fresh cut palm fronds but probably because their pasture quality is too poor.

Your market

If you sell young cattle, you must have a high weaning percentage to be profitable.

Markets are likely to remain opportunistic until the industry grows and supply chains are established. Important factors for markets include access to shipping, proximity of local feedlots and abattoirs and strength of smallholder demand and purchasing power.

Market options in Indonesia for male cattle and culled heifers will be a mix of the following:

- Sell young cattle to local farmers at 200+ kg - they will be lighter but of higher value / kg
- Sell bulls to feedlots at 300 kg – strong demand but they compete with Australian feeder steers price.
- Sell bulls at Idul Fitri or at Qurban – both festive occasions see the highest prices paid for cattle. Specifications differ depending on location and local culture.

Size and location of the breeding cattle herd will dictate the marketing options. It is important to remain aware and flexible in your marketing strategy.

Markets are also required for sick and dying cattle which necessitates having contact details and a relationship with a local buyer. Usually the nearest abattoir will be able to assist.

2.7.2. Different production systems

The different production systems in Indonesia– SISKA, breedlots and open grazing– have markedly different breeding systems.

SISKA

SISKA enterprises use the existing pasture resources under oil palms for semi-intensive grazing of breeding cattle. Cattle are rotated through the palm blocks in a cell grazing system completing a full cycle in 60 to 90 days.

Cattle move through the stockyard at least once during each rotation. This provides an easy opportunity to draft out calves for weaning. If needed, portable drafting yards can be used at any time during the rotation to segregate animals needing special treatment, including weaning.

Special attention is required to keep cows and new weaners apart because the electric fencing used in grazing blocks is an insufficient barrier to counter to cow-calf bond. It can be better to truck weaners to a different area so that they are physically and audibly separated from their mothers.

Weaners should be moved to a secure paddock with good quality pasture and additional supplements as required. Ideally, an open (full sunlight) paddock with improved grass-legume pastures should be prepared for this purpose.

Weaner growth rates will be lower than their potential if grazing pastures under oil palm unless protein or energy supplement is provided. Mineral supplements, especially phosphorus, are essential on acid soils.

One of the aims of the oil palm operation is to keep any pasture under the palms short to facilitate collection of palm fruit but without damaging the palms.

The SISKA system is complex and the best options are still developing.
Animal performance is controlled by palm density.

The oil palm side is more profitable than animal production but grazing provides many benefits.

Regular, high-intensity grazing prevents cattle concentrating on the preferred pasture species and eventually results in even pastures. However, it does reduces the opportunity for cattle to selectively graze the most nutritious herbage. This poorer diet can reduce potential weight gains of breeding or growing stock and hence the recovery of body condition.

Weaning rates may be lower than their potential unless protein or energy supplement is provided, and this may not be economical. Mineral supplements, including phosphorus, sodium and sulphur, may be essential for cattle grazing pastures on acid soils.

Open grazing systems

Grazing herds of cattle on permanent pastures without a plantation cover is a more traditional system in eastern Indonesia.

Costs of production are lower as less labour is employed but there are no financial benefits flowing from a plantation. All stock must be inspected regularly for health and parasites.

In most cases bulls are run with the cow herd throughout the year. Calving rates are generally around 60 - 70%, with a calf every 18 months. Mineral supplements, especially of phosphorus, are provided.

Calves may be weaned at 5-6 months at regular interval throughout the year. Infrastructure for fencing, waters and yards tend to be permanent.

Breedlots

Breedlots are a unique operation for beef cattle. Cattle infrastructure is expensive and cow pregnancy rates have to be high as feeding unproductive cows in yards is expensive.

Thus very early weaning (at 3 months) has been used to achieve regular annual calving.

Details for feeding and caring for these very young weaners is given under Breedlot weaning guidelines.

Open grazing systems are the cheapest production system. Some areas may coordinate with the SISKA system.

Breedlots are an expensive operation and so demand high rates of calving and growth.

2.8. Animal health

2.8.1. Typical problems

All SISKA enterprises will encounter a similar range of health issues with their breeding cattle.

From past experience of breeders in Sumatra and Kalimantan, about 90% of common health problems are easily identified and treated using a modest kit of locally available veterinary chemicals and equipment.

Common health problems (in decreasing order of occurrence)

- Parasites – both internal and external, including myiasis especially of calves.
- Lameness –especially in oil palm plantations where the thorns from the fronds easily penetrate the feet of cattle.
- Bovine Ephemeral Fever (BEF) – "3-day sickness"
- Prolapsed vagina, retained placenta and dystocia
- Wounds, abscesses and accidents
- Calf problems – mis-mothering, failure of milk supply, diarrhoea, joint ill, pneumonia
- Abortion

All field staff in each location should receive a training session where all these health problems and treatments are explained and demonstrated.

The cattleman's bum bag

Cattlemen's bum bag

Whenever a stockman is in the field and likely to be interacting with cattle, he should carry a small pack (bum bag) containing:

- 1 ml and 10 ml syringe and 18g x 11/2 inch needles
- 1 bottle Dectomax® injection
- 1 can Gusanex® spray
- small bottle with iodine wash
- 1 bottle long-acting antibiotic, e.g. oxytetracycline, injection
- 1 bottle anti-inflammatory
- Thermometer
- Pole syringe injector

Standard treatment of a new born calf should include:

- Newborn with no problems – spray Gusanex® and iodine wash on the navel to protect from flies , infection and myiasis.
- Navel strike with myiasis/swelling or infection – inject ivermectin, long-acting antibiotic and anti-inflammatory injection.

Do not waste money buying vitamin injections.

Table 1: Common ailments, treatment and commercially available veterinary products

Problem	Treatment type	Products available commercially
Parasites		
Ticks and internal parasites	Injectable ivermectin including fluke treatment Pour-on mectin	Intermectin Super®, Ivocip plus®, Ivomec F® injection, Ivomec Super® and many others. Paramectin RV® pour-on; Duphamec® pour on
Myiasis including newborn calf navels	Same as above plus topical spray	Above injection plus Gusanex® or other topical spray which includes lavicidal compounds. Dectomax® injection is best. A squirt from a pour-on can work if animals cannot be captured to inject
Lameness	Remove any thorn from foot. If infected, inject antibiotic and anti-inflammatory. If no infection, use only anti-inflammatory.	Antibiotic – Ceftiofur injection (Exfo®); long acting oxytetracycline – many available – terramycin LA, etc. Anti-inflammatory – Flunixin® injection, Flunixvet® injection, Flumav® injection, Tolfidine® injection DO NOT USE DEXAMETHASONE
BEF and pneumonia	Antibiotic and anti-inflammatory	As above – Exfo® and anti-inflammatory injections – same for adults and calves
Navel strike		
Navel strike with screw worm	Injectable ivermectin and topical larvacide treatment	Dectomax® injection as above Gusanex® or other spray as above. Antibiotics and anti-inflammatory inj.
Navel ill	Antibiotics and anti-inflammatory	As above
General		
Mis-mothering	Milk and oral fluids	Milk replacer powder Calf bottle and stomach tube Calf Magic® oral electrolyte powder
Prolapse vagina, uterus, dystocia	Antibiotic Anti-inflammatory Local anaesthetic injection	As above Bruners needle
Wound Abscess Accidents	Antibiotic Anti-inflammatory Topical spray	As above
Flies	Back rubber	Insecticide with suitable oil

Screw worm attack of scrotum must be treated with insecticide.

Screw worm infection after inserting an eartag

Vet Kit

As a guide, for a herd of 300 breeders and calves, the following vet kit represents a reasonable composition to last for about 6 months.

1. For treatment of illness

- 6 x 50 ml Dectomax® (myiasis, not fluke)
- 5 x Exfo® injection
- 5 x 100ml Terramycin® LA
- 10 x 100ml Flunixin®
- 10 x spray cans Gusanex®
- 2 x 100ml bottles local anaesthetic
- 20 x Calf Magic® electrolyte powders

2. For routine treatments of the herd when brought to the yards

- Ivomec Plus® or similar injection – includes fluke treatment

or

- Paramectin Pour-on

With volumes calculated to allow all cattle in the herd to be treated.

- Fly-repellent chemical to mix with suitable oil and apply to back rubbers.
- Calf milk replacer

Use dish-washing liquid as a disinfectant

Equipment

- Digital Thermometers x 3
- Syringes and needles – 1 ml, 10ml and 20 ml, needles 1 ½ inch x 18 gauge
- Back rubbers – these can be home made.
- Bruners needle for prolapses
- Calf drinking bottle and stomach tube
- 1 x box scalpel blades
- Bum Bags
- Pole syringe with spare needles and syringes

A suitable quantity of products to last 300 cows and calves for one year should not cost more than Rp20 million. This includes whole-herd treatments for parasites at least twice per year. Note – this is about the value of one cow.

Rubbing to relieve irritating fly has opened this bull's hide, allowing infestation by screw worm fly.

2.8.2. Backrubbers

Backrubbers are useful for reducing fly problems on grazing cattle. Fly-affected animals soon learn to use the backrubber to seek release from the pests.

Basically a backrubber is a porous material soaked with insecticide in old engine oil and suspended between two points. The oil and insecticide spreads along the animal's back as it walks under the rubber.

Simple backrubs have been on stations using rolled jute felt or hessian bags in fishing netting. These can fed from a drum reservoir or 'watered' daily with 1 litre of oil and insecticide. Any sag or slope must allow for animals of different height but to reduce excessive drainage.

Materials to make an on-site self-feeding backrubber include:

- 6 m of chain
- 6 m of 20mm hose with small holes drilled into it along its length to allow the oil to slowly leak out
- Jute felt or hessian 4 metres wide, rolled up until it forms a sausage shape about 20cm diameter
- This 'sausage' is wrapped in nylon fishing net mesh
- Ropes attached to each end of the chain to tie it to trees or posts.
- One end of the drilled hose is connected to the tap of a 20 litre drum of oil/chemical
- Tap is adjusted so that the product wets the back rubber but does not drip onto the ground.

Locally-made back rubber being treated with insecticide

The setup of a proprietary brand (A C Backrubs®) of backrubber available in Australia (see www.buffaloflycontrol.com).

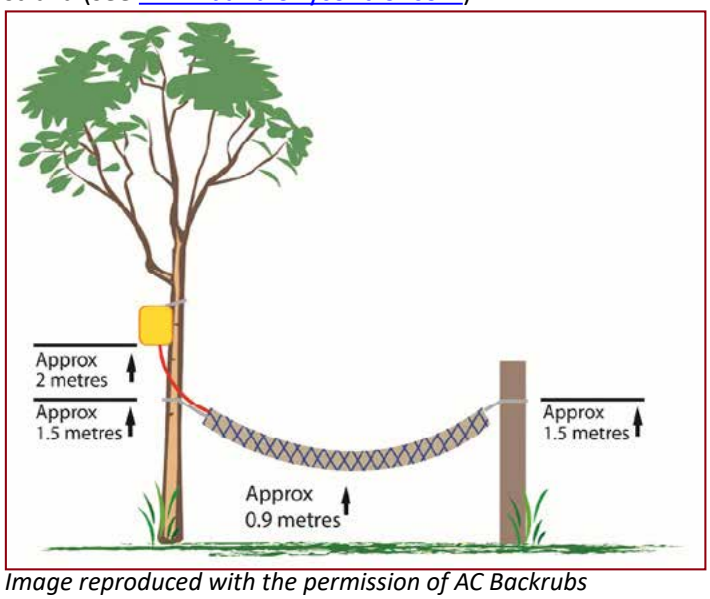


Image reproduced with the permission of AC Backrubs

Backrubber placed near feed trough

Problems under the SISKA system include the need to move the backrubber between blocks, shelter for the backrubber from high rainfall, anchorage between palms, and suitable insecticide and lubricant.

Note:

- Currently no insecticide is registered in Indonesia for use in backrubbers.
- Waste engine oil is not recommended in Australia but hydraulic oil is permitted.
- In Australia, a specific backrub oil has been developed to retain viscosity under high temperature while remaining tacky.
  This oil can be mixed with registered buffalo fly control product.
- The Australian company (AC Backrubs®) has made a mobile frame that can be towed for easy relocation under cell grazing systems.

2.8.3. Parasite management guidelines

Internal parasites are an important cause of economic loss in cattle. They need to be managed in a way that minimizes losses while keeping the costs of control to a minimum, and minimising the risk of developing resistance to commonly used chemicals.

Efficient management of internal parasites in cattle involves:

1. measure the level of infection

2. decide on the appropriate course of treatment.

Fresh samples of manure are sent to the laboratory to be examined for worm eggs. The type and number of worm eggs will help the cattle manager/veterinarian to decide if treatment is necessary and, if so, the appropriate treatment.

Young calves can be heavily infected with the round worm Toxocara vitulorum when the larvae are passed in the mother's milk.

T. vitulorum is a large and obvious worm. Most species are too small and need laboratory testing to ascertain levels of infection.

Types of internal parasites

The common types of internal parasites of cattle in Indonesia include round worms, liver fluke, stomach fluke and coccidia. The protozoa coccidia can be important - especially in young calves. All of these parasites can cause illness and reduce performance if they are present in high numbers.

Symptoms

The most common symptom of roundworm infestation is often the least recognised – reduced productivity from lower growth rates and milk production. More obvious symptoms of heavy worm infestation in young cattle include diarrhoea, anaemia, 'bottle jaw' (oedema), dehydration, loss of body condition, rough coat, ill thrift and death.

Young animals are most susceptible to the affects of parasites and should be the main focus for parasite management while mature cattle develop strong resistance over time.

Sampling

Samples can be collected direct from the cow (during pregnancy testing) or from the ground in the kandang or in the grazing area. Fresh manure samples can be collected from the ground but avoid collecting soil or other contaminants.

As a guide, collect a sample of dung, about 50 grams, from at least 10 fresh manure deposits from different cows within the same group. This can be done using a pregnancy testing glove as all the individual samples can be combined in the one glove as a final single sample for sending to the laboratory. Take a separate sample from each group e.g. one group sample from the grazing herd and a group sample from each yard in the kandang. Samples from calves and weaner groups are especially important. The aim of this process is not to identify individual animals that are infected but which groups (if any) are infected so the whole group can be treated if necessary

Once the sample is collected, keep it out of the hot sun, seal it in a zip-top bag and store it in the refrigerator until it is dispatched to the laboratory. Dispatch these combined samples to the appropriate laboratory in packaging that will prevent leakage of the contents. Refrigeration during transport is not required.

2.8.4. Testing

In the laboratory, each sample is thoroughly mixed, diluted and examined under a microscope where the eggs are identified and each type counted. The results are presented as eggs per gram of manure for each type of egg found. Many of the round worms have similar eggs so if a specific worm is being sought the eggs are cultured until they develop into larvae for identification.

A list of reputable laboratories that provide parasite testing services is provided at the end of this section

Interpreting laboratory results

Low numbers of eggs indicate very low levels of worm infestation where treatment is usually not necessary. Each worm species has a specific egg count number that reresents a high level of infection and indicates that treatment is necessary.

Worm type	Level indicating possible treatment (eggs/gram)
Haemonchus	200
Toxocara vitulorum	?
Oesophagostomum	100
Cooperia	500
Liver fluke	5
Stomach fluke	unreliable
Coccidia (protozoa)	More than 5,000 oocysts per gram

Microscopic view of a Toxocara vitulorum worm egg

2.8.5. Treatment options

A wide range of products is available to treat internal parasites; some are specific, others broad spectrum. With the results of the types and numbers of worms present in the cattle, discuss the most appropriate treatment with your veterinarian.

Albendazole is a broad-spectrum worm treatment suitable for calves but NOT SUITABLE for adult females that might be pregnant as it can cause birth defects or abortions.

Injectable Ivermectin products are commonly available, cheap and effective. These cover round worms in the gut as well as external parasites.

Injectable ivermectin products sometimes include a separate chemical for the treatment of liver fluke and this is an ideal treatment when both round worms and fluke are identified as needing treatment

Pour-on products such as Paramectin Pour-On® are easy to apply and treat internal round worms and external parasites but, like ivermectin, do not treat fluke or tape worms.

Coccidia require specific chemicals for their treatment. Ask your veterinarian for advice.

Table 2: Location and dispatch address of veterinary laboratories capable of conducting the necessary testing for worm egg counts

Instansi (Agency))	Alamat and no tlp (Address and phone)	Remarks
B-Vet Lampung	Jl. Untung Suropati No. 2 Labuhan Ratu (1.159,56 km) Kota Bandar Lampung (0627) 2170 1851 Email: bvetlampung@pertanian.go.id	Coverage area: Lampung, Bengkulu Fee for test: Rp 6000 / sample Staff receiving samples: Ibu Hermin
B-Vet Banjarbaru	Jl. Ambulung No 24. Loktabat Selatan Banjarbaru Kota Bandar Lampung (0627) 2170 1851 Email: bvetlampung@pertanian.go.id	Coverage area: Kalimantan, incl. Pangkalan Bun, Banjarmasin Fee for test: Rp 7500 / sample Staff receiving samples: Bpk Taufik Veterinary: Drh Nurjanah Hp: 0853 4563 6699
B-Vet Wates	Jl. Raya Yogya - Wates Km 27. TP 18 Giri Peni. Eates Kabupaten: Kilon Progo Daeah Itsimewa Yogyakarta 55602 (0274) 773 168	Coverage area: Central Java Fee for test: Rp 3000 / 10 gm sample Staff receiving samples: Ibu Novi
B-Vet Subang	Jl. Terusan Garuda Blok Weasari Dangdeur Subang 21212 - Jawa Barat Tlp. 0260-742 3134 Fax: 0260-742 3178 Email: info@bvetsubang.com	
BB-Vet Denpasar	Jl. Raya Sesetan No 266, Denpasar Kotak Pos 3322 Tlp. (0361) 720 862, 720615 Fax: (0361) 720415 Email: bbvet.epi@gmail.com	Coverage area: Bali Fee for test: Rp 14000 / sample Staff receiving samples: Bpk Wisnu

Calf needing help to suckle this second calf cow in poor condition. The cow rejects calf to save herself; she will need supplementary feed, the calf may need milk replacer.

2.8.6. Mis-mothering

A first-calf heifer will often reject her calf immediately after birth and refuse to allow it to suckle. This has occurred with about 5% of the 1,300 heifers imported through IACCB.

Mis-mothering is more common when the heifers have had recent stress, such as the long journey from northern Australia to Indonesia. Calve them close to the kandang, and watch carefully. Older cows commonly mis-mother if they are in poor BCS, and the calf will die unless it can be fed in the kandang.

Treatment

Ensure the cow has access to as much good quality fresh forage, such as young king grass, as it can eat . Supplement this with 0.5kg soybean meal, or another high protein feed source. Feed 5 kg per day of fresh legume leaf such as leucaena, sesbania and indigofera. Provide clean drinking water at all times.

Lock the cow up and encourage the calf to drink naturally. Sometimes it works, but not always.

If the calf is too weak or distressed to suckle on its own, the stockman should milk the cow and feed the calf with a bottle 3-4 times a day, especially with a skinny cow.

Once the calf has been fed for a few days the cow will usually accept it and they can continue naturally.

If the cow does not have enough milk, the calf will need milk replacer.

2.8.7. Abortion rates in imported heifers

Relatively high rates of abortion have been recorded in some IACCB herds. While rates of abortion of 2–3% are common, rates with first and second calf heifers were approaching 10% in one herd. Abortion can be related to travel stress in recently arrived heifers, but that should not persist for more than a few months after arrival at the destination farm.

The high rates of abortion could well be related to viral diseases common in Indonesia but not in northern Australia. Once exposed to these diseases, the cows will develop a level of immunity but after an increased rate of abortion. Imported cows tend not to have significant levels of abortions from the second calf onwards. However, if the problem persists beyond the first year after importation, further diagnosis will be necessary.

2.8.8. Treating uterine prolapse

Uterine prolapse occurs at the time of birth. It may only occur in less than 1 case in 2-5,000 births, it is shocking and needs to be addressed urgently or the cow will die. Uterine prolapse should not be confused with vaginal prolase, which is more common and relatively easy to successfully treat.

When the calf is born, the cow continues to push and this can sometimes result in the entire uterus being pushed outside of the body. While the principles of treatment are relatively simple, the task is physically challenging.

The treatment process is to move the cow to a location where it can be handled and the uterus pushed back into its normal position. It may be able to be slowly walked back to the yard where it could be handled and treated safely.

When the uterus is outside the body, the cow feels as though she is still giving birth and continues to strain. The cow's urge to push is so powerful that it is usually impossible to replace the uterus without first stopping the straining process.

The first part of the treatment must be to give the cow an epidural anaesthetic, which numbs the tail and vagina area of the cow. Once the cow stops straining, the uterus should be cleaned and lubricated before being pushed back through the vagina and into its normal location inside the abdomen. When the uterus is outside the body it may swell making replacement even more difficult, so the treatment should start as quickly as possible.

Replacement is usually best achieved with helpers to support the uterus and to help to push it back in at the right time. The replacement can be done in the standing position or with the cow is laying down if she cow is too weak to stand. In this case, the cow should be sitting upright with its back legs pulled out behind it and the rear of the cow elevated for gravity to help replacement.

Once the uterus has been replaced, it needs to be manipulated inside to ensure that it is fully returned to its original shape. After this, a large suture is placed in the vagina to hold the opening closed and prevent the uterus from being expelled again.

After giving birth to a live calf, this cow continued to strain causing a uterine prolapse.

The prolapse has been pushed back in and the vagina tightly sutured – allowing urination but no further expulsion of the uterus.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1045
070

2.9. Energy and protein rations

2.9.1. Introduction

All sections in the Herd Management module refer to this Section on Energy and Protein Rations as it suggest rations and supplements for local beef production.

The more an animal eats, the larger it will grow. However, ruminants can only eat as much as their rumens can break down and digest – or as much as is available in their pasture or their trough. When the base feed is derived from grass or cereal by-product that is low in digestible energy or protein, their feed intake can be increased by supplementing with high energy or protein products.

The most cost-effective rations for any enterprise will depend on:

- The quality of the base feed – either pasture or a dominant by-product
- The quality and cost of locally available by-products.

These factors vary between regions and may be seasonal. Thus the best rations and supplements are often specific to each enterprise, may change with the seasons and class of stock being fed, and are likely to constantly evolve as products change in cost, availability and quality.

Cattle production systems in Indonesia are generally based on low quality pastures and crop residues that do not support reasonable rates of growth or even maintenance, and energy and protein supplements will normally be required to improve the quality of the base feeds. Cattle also require minerals essential for body and rumen functions and for the development and maintenance of bones.

Most tropical pastures in high rainfall zones are deficient in minerals such as phosphorus, sulphur and sodium and these must be provided. Trace elements such as cobalt, copper, manganese, selenium, iodine, zinc and iron are required but deficiencies have not yet been recognised in this region.

An experienced ruminant nutritionist should be consulted whenever rations are formulated for the first time as poorly developed rations could be costly, may deliver poor production and could be dangerous to animal health.

2.9.2. Local energy and protein feeds

Table 1 shows a range of local and imported feeds commonly used in rations for cattle and comments on their protein and energy content. Some feeds may have anti-nutritional or palatability factors that limit the extent of their use in a ration. Small changes in a ration formulation can result in significant changes in intake and performance.

Table 1: Locally available by-products and other feeds that can be used in rations for cattle

Bahasa	English	Comments on quality
Agricultural by-products		
Onggok	Cassava waste	Low in starch and fat; a safe feed; medium palatability
	Wheat pollard	High starch, medium protein; highly palatable and can lead to acidosis if fed too much
	Spent brewers grains	Usually about 30% dry matter; medium starch, fat and protein; fairly safe and high palatability
Dedak	Rice bran	High fat, medium protein and high energy although energy mostly from oil.
	Corn bran	High fibre; low starch; palatable.
Bungkil sawit	Palm kernel cake (PKC)	Medium palatability; careful with high oil content; medium protein; low starch so safe
Solids	Palm oil mill sludge	Cheap ration additive but high fat content will cause acidosis. Recommended maximum inclusion rate is 10%
	Pineapple pulp	High energy, low protein by-product. Very high water content - 85%. Low-moderate palatability with novice cattle but eaten readily eventually
Bungkil copra	Copra meal	High palatability; medium oil content and protein; low starch so safe
Tetes tebu	Molasses	High energy and palatability, low protein. Used to increase palatability and intake of low-quality roughages
	Rice hulls	Low quality roughage- high fibre; low starch, protein and energy
	Cocoa bean shells	High palatability; high fibre; low starch
	Coffee hulls	Lower palatability, high fibre, low starch
Grains and strach crops		
Jagung giling	Cracked corn	High in starch so watch for acidosis; low protein; low oil; very palatable; best cracked rather than crushed.
Gaplek	Cassava chips	High in rapidly fermentable starch; will cause acidosis; low protein; medium palatability
Bungkil kedelai	Soybean meal	High palatability, high protein quality, medium starch. Fat may depend on process;
	Green bananas	High energy and palatability, low protein.
Crop stubbles and straws		
Jerami	Rice straw	Low quality roughage used as maintenance feed with additional protein supplements
	Sugarcane tops	Fresh leaves are a moderate quality roughage. Old leaves low quality
Batang sawit	Oil palm fronds	Young leaves are a moderate quality roughage. Old leaves low quality
High-quality forages and fodders		
	Green chop- young corn or forage sorghum	Very high effective fibre; high moisture; needs to be cut into lengths of 5cm or less; low-moderate protein.
Rumput gajah / rumput rajah	Elephant / king grass	Quality declines rapidly with age – cut at 60 days for best combination of yield and quality
Lamtoro	*Leucaena leucocephala* leaf	High quality protein. Generally highly palatable
Gamal	*Gliricidia sepium* leaf	High quality protein. Moderate palatability at best and low palatability with novice cattle
Turi	*Sesbania grandiflora* leaf	High quality protein. Generally highly palatable
Indigofera	*Indigophera zollingeriana* leaf	High quality protein. Generally highly palatable

2.9. Energy and protein rations

Nutrient content and price of local feeds

Table 2 provides a guide on price of common ration ingredients on an "as fed" basis. This refers to the price based on the normal moisture content of the feed, for example, rice straw will normally have a dry matter (DM) content of 85%, so that one kilogram of rice straw will include 150 g of water. This is important when developing a ration because the protein and energy value of the feed are only related to the DM component – the rest is just water. Thus mature king grass is substantially cheaper than young king grass on a DM cost basis but has much lower quality.

Table 2. Nutrient content and price of local feeds

Ingredient	Cost as fed (Rp/kg) *	Dry matter (DM) %	Cost as DM (Rp/kg)	Protein (%)	Energy (MJ/kg)	Crude fibre (%)	Fat (%)	Ca	P	Max in ration
Agricultural by-products										
Dry onggok (dried cassava waste)	1500	90	1667	1.5-2.5	10-12	6	1	0.6	0.2	<50%
Wet onggok	350	35	1000	1.5-2.5		6	1			35%
Rice Bran (polishings)	1650	90	1833	15-16	10-11	6.6	15	0.07	1.6	15-25%
Wheat pollard	2200	90	2444	17-19	10.5-12	10	4.5	0.2	1	45%
Spent brewers grains		22		15.5-16.5	10-13	15		0.33	0.13	15%
Palm kernel cake (PKC)	800—1600	97	1031	14.5-19.6	10.5-11.5	14	8.4	0.3	0.7	50%
Palm oil sludge	100	35	286	1600%	12.5-13	25		0.5	0.3	10%
Copra meal	3500	90	2000	18-22	12-14%	14	13.5	0.2	0.7	15%
Molasses	2000	81	2469	2-4	9–11	1	2	0.6	0.2	15%
Cocoa hull		91		10-12	9	14		0.15	0.27	10%
Coffee hull				10-12	5					
Pineapple pulp		12		3.3	10	26		0.4	0.1	20%
Grains and starch crops										
Soybean meal (SBM)	4400	90	4889	45-48	11.5-13	4.3	4	0.27	0.7	5-10%
Crushed corn	3500	90	3889	8-10	11-12	3.5	4			
Gaplek (dried cassava chips)	2400	90	2667	2.5-3.5	12.5-13	10	0.5			45%
Green bananas		22		5.75	13	4		0.06	0.2	<60%
Crop stubbles and straws										
Rice straw	250	85	294	3-4	6-7	30	2			
Oil palm fronds	400	40	1000	6-8		36	2.5			
Young King grass	600	20	3000	9-12	10-12	24	2.5			
High-quality forages and fodders										
Old King grass	500	25	2000	6-9		36	2.5			
Green chop- young corn or forage sorghum	500-800	22	3000	7-8	10-11					
Leucaena leaf		22		26.7	11	21		2.2	0.3	10%
Trace elements and addititives										
Urea	3800	100	3800	285				0	0	<2%
Salt	650	100	650							
Limestone	500	100	500					34	0	
DCP (Dicalcium phosphate)	2000	100	2000					22	19.3	

**Prices may vary considerably depending on location and availability.*

2.9.3. The feed base

The dominant feed will be the understory pasture in SISKA, it might be chopped king grass or young corn in a breedlot. In an open grazing system, the feed base will be a mix of native and improved grasses and legumes. Many smallholder farmers use rice straw and other crop residues as the feed base.

The feed base will dictate the requirements for supplementary concentrates and feeds but these may change during the year if it relies on a seasonal product. The feed budget must be planned carefully to ensure that feeds of the appropriate quality are constantly available.

Cattle will naturally prefer higher quality feeds to those with lower protein and energy content and lower palatability. Adding higher quality supplements to a low-quality base feed often stimulates overall intake at first. The extra protein in the supplement stimulates rumen microbes, improving fermentation and digestion resulting in higher growth rates. If too much supplement is fed, some "substitution" may occur with the cattle eating less of the cheaper base feed. A good nutritionist will be able to determine the most economic rate at which the supplement should be added.

King grass or chopped corn as a feed base

Much cattle production has been based by king grass or young corn plants. These forages provide moderate quality ration while the energy and protein contents can be boosted with high-quality supplements.

Fertilised king grass can produce 40–60 t DM/ha /year on good soils. It should be harvested at 55–60 days regrowth while the stems are soft and the protein content high with intake improved by chopping to lengths of 4-5 cm. By 80 days, the regrowth is low quality feed.

Understory naturalised grasses and herbs

Cattle eat from a wide range of grasses and herbs growing in the oil palm understory, and these pastures are discussed in more detail in Module 3. Most understory pastures growing under heavy shade are of low to moderate quality – often sufficient to maintain the condition of dry cows and support some growth (0.1 to 0.25 kg/day) of young cattle. But high quality supplements must be supplied to achieve acceptable growth rates of young cattle, improve the body condition of low BCS cows and to maintain the body condition of lactating cows.

Stored forages

Some forages are stored to provide feed during periods of dry weather. Grass can be cut at an early flowering for hay if it can be dried effectively but in most areas of Indonesia, forage is stored as silage. To produce good silage air must be excluded from the forage to encourage anaerobic fermentation of the sugar. Failure to exclude air or to prevent infiltration of rain water will result in rotten feed of low value. Rubbish in, rubbish out. Good hay or silage cannot be made from low quality forage.

Rice straw as feed

Feeding rice straw alone will not maintain the body condition of cattle. Because of its high fibre and low nutrient content, cattle will eat only the equivalent of about 1.5% of their weight as rice straw on a dry matter (DM) basis each day. At 1.5% of its liveweight, a 400 kg cow will consume 6 kg of dry rice straw daily, and this will meet only 60% of the daily energy requirements for a dry cow.

Spraying urea solution over rice straw

If the rice straw is relatively fresh with a DM content of 35%, consumption will be 6 kg / 35% DM = 17 kg/day. If an extra 15% is provided in case the cow can eat a little more, the farmer would need to provide 20 kg/day of rice straw to each cow. Chopping rice straw into 5 cm lengths will improve intake slightly but not quality.

Adding some urea and sulphur will increase consumption of rice straw to about 1.8% of live weight (on a DM basis), and will increase the recommended feeding rate (400 kg x 1.8% = 7.2 kg DM / 35% DM = 20.5 kg + 15% extra) to 24 kg rice straw/day. Even then, dry cows are unlikely to maintain their body condition and wet and heavily pregnant cows will lose condition rapidly. Soybean stubble has a slightly higher quality than rice straw.

Additional higher-quality supplements, such as leaf of tree legumes lamtoro (*Leucaena leucocephala*) or indigofera (*Indigofera zollingeriana*), palm kernel cake, copra meal or soybean meal will be required.

Urea as a supplement

Urea is a cheap form of non-protein nitrogen that can be used in very small quantities to improve the rumen-degradable nitrogen content of low-quality feeds. Adding urea to rice straw will help to maintain body condition, but will still not be sufficient on its own to support growth.

When urea is to be provided to cattle for the first time, it should be provided at 25% of the desired amount for the first week, with the amount gradually increased to the full amount over a period of one month. Seek professional assistance when commencing a urea supplementation program.

Urea can be spraying as in the photo on the right, or poured over the rice straw using a watering can. Dissolve 60 g urea plus 15 g ammonium sulphate (ZA) in 500 mL water and water the rice straw ad lib. If the ZA is in a granular form it may need warm water to dissolve.

Rice straw can be ensiled by treating with urea to improve digestibility and intake. Ensiling generally takes at least 21 days.

Poisoning from eating urea fertiliser

Urea poisoning

Too much urea in feed can kill. At one SISKA enterprise in Sumatra, cattle rapidly became ill when too much urea was added to the drinking water. Of the nine head affected, three required emergency slaughter while the others could be treated and later returned to the herd.

Cattle can die from eating clumps of urea used to fertilise the oil palm because the fertiliser was applied immediately before the grazing rotation. Fertiliser should always be applied soon after the grazing round to avoid any risk of urea poisoning.

Urea should never be available in concentrated raw form, but should be mixed with other feeds at a maximum of 2–3% in the total ration. It should be included gradually into the ration, commencing with around 25% of the desired final amount and increasing gradually over a period of 4–6 weeks. Seek professional advice when commencing a urea supplementation program.

Other low-quality feeds

A range of by-products and low-quality grasses are commonly fed because they are cheap and readily available. Poor quality feeds will always reduce growth potential but can be included into a ration for dry cows and other classes of stock because of their low cost.

Oil palm leaf – Oil palm plantations generally feed pruned oil palm leaves in the paddock or in the kandang. Chopping the leaf will increase intake, but cattle prefer to select the more palatable components of the leaf (see photo of stripped fronds). As with all forages, the younger the leaf, the better its quality will be.

Corn stalks / stover – Corn stalks collected from freshly cut corn (left) can be reasonable forage where the stalks are green and not yet too fibrous. Corn stalks are sometimes available when a crop fails due to low rainfall or pest damage. Cutting to a length of 5cm will improve intake and feed value.

With stover (right) collected from dry corn, its insoluble fibre content increases while protein content declines sharply with age. Corn stover will usually have a higher content of minerals, such as phosphorus, than rice straw. Again, chopping to 5cm size will assist with intake.

Corn husks – Some smallholder farmers use corn husks as a component of their ration. Corn husks have very low protein content – around 1–2% - and are extremely high in indigestible lignin. Intake of corn husks is always very low and is unlikely to be significantly improved with urea treatment. Corn husks are poorer quality than rice straw.

Corn cobs – jenjet – Corn cobs are commonly milled to produce a low-quality ration component, particularly in some smallholder production systems. Known locally as jenjet, corn cobs are high in insoluble fibre and low in crude protein (around 2.5% CP). The small particle size after milling should improve intake but can cause an impacted rumen if fed to excess.

Mature grasses – A wide range of grasses are cut early in the dry season and used as dry season feed. Once grasses have flowered, their nutritive quality declines rapidly, putting them in the same class as rice straw, sugar cane tops or corn stover. Cutting the grass while still green and in the early flowering stage will provide good quality hay.

Soybean stubble – Soybean stubble is generally of slightly better quality than other stubbles. Being a legume, it has higher crude and mineral content and less structural fibre than grasses.

Sugarcane tops – Sugar cane tops of predominantly green leaf are similar in quality to a wide range of other low-quality forages. It generally has a dry matter content of 35-40% , 40-50% digestibility, 5-7% crude protein and 7- 8 MJ / kg metabolisable energy.

Cattle will strip young leaf from oil palm fronds

Green corn stalks (above) are reasonable quality feed; corn cob – jenjet (below) is poor quality.

2.9.4. Mineral mixes

Minerals provide essential minerals that may be absent in forages and rations. Mineral mixes are generally added to the bulk rations in relatively small amounts, usually at a ratio of 1 to 7% of the total ration. As forages in Indonesia are commonly deficient in sodium, salt is the most common mineral provided to cattle to make a dramatic impact on feed intake and productivity.

Phosphorus is similarly deficient in many forages and rations due to the low P-status of most Indonesian soils. Some by-products, such as palm kernel cake (PKC), are naturally high in P; when PKC is fed, no additional P is generally required.

Calcium is particularly important for lactating cows as milk production requires large amounts of calcium. Calcium is generally obtained from limestone and dicalcium phosphate.

Sulphur is also commonly deficient in heavy leached or regularly burnt country. Sulphur is essential as a major component of proteins formed in the rumen. Sulphur is a component of ammonium sulphate or can be added to a mineral mix as elemental sulphur.

Minerals are often provided with molasses-based salt blocks that can also contain phosphorus, calcium sulphur and other essential trace elements or as a mix that is added to rations fed in the paddock or kandang. Check that your local salt blocks do contain adequate phosphorus.

The mineral mixes listed below have been developed for different classes of cattle consuming a range of base rations. The concentrates and supplements provided throughout this section include these specific mineral mixes to form balanced rations.

Table 3. Mineral mixes

Options	Ingredient	Pakan	Inclusion rate	IDR/kg	Cost of ration
1	Limestone	Kapur	35%	3,000	1,050
	Salt	Garam	35%	2,000	700
	Dicalcium phosphate	DCP	30%	11,000	3,300
			100%		**5,050**
2	Limestone	Kapur	30%	3,000	900
	Urea	Urea	20%	3,000	600
	Salt	Garam	50%	2,000	1,000
			100%		**2,500**
3	Salt	Garam	45%	2,000	900
	Dicalcium phosphate	DCP	45%	11,000	4,950
	Ammonium sulphate	ZA	10%	2,000	200
			100%		**6,050**
4	Salt	Garam	40%	2,000	800
	Dicalcium phosphate	DCP	40%	11,000	4,400
	Ammonium sulphate	ZA	5%	2,000	100
	Urea	Urea	15%	3,000	450
	Total		100%		5,750
5	Limestone	Kapur	10%	3,000	300
	DCP	DCP	20%	11,000	2,200
	Ammonium sulphate	ZA	10%	2,000	200
	Urea	Urea	35%	3,000	1,050
	Salt	Garam	25%	2,000	500
	Total		100%		3,750

2.9.5. Concentrate and supplements for different classes of stock

The section below provides a range of options for feeding different classes of cattle

In all cases, the assumption is that cattle will have unrestricted access to forage, roughages or pasture. The rations have been formulated to provide the specific class of stock with the protein, energy and minerals that they require for production. The concentrates and supplements used by each enterprise will vary depending on the cost and availability of feeds.

Care should be taken to ensure that supply of particular feeds meets the requirements for a particular period. Cattle do not like to have their diets changed abruptly as their rumen microbes need time to adjust to different feed types; rapid change in diet can result in feed rejection and poor growth or weight loss during the transition period.

Concentrate for calves 0-3 months of age

The ration has approximately 19% CP (DM basis) and is for early-weaned calves that have unrestricted access to forage. It is also a 'creep mix' for suckling calves in a breedlot or when housed overnight in the kandang. It is best fed in small amounts at regular intervals to encourage the calves to eat it.

Table 4. Concentrate for calves 0-3 months of age

Options	Ingredient	Pakan	Inclusion rate	IDR/kg	Cost of ration
1	Soybean meal	Bungkil kedelai	25%	5,000	1,250
	Cracked corn	Jagung giling	57%	4,500	2,565
	Rice bran	Dedak	10%	2,300	230
	Molasses	Tetes tebu	5%	2,000	100
	Mineral mix 1	Mineral mix	3%	12,000	360
	Total		100%		**4,505**
2	Copra meal	Bungkil kopra	42%	3,500	1,470
	Cassava chips	Gaplek	35%	3,000	1,050
	Soybean meal	Bungkil kedelai	15%	5,000	750
	Molasses	Tetes debu	5%	2,000	100
	Mineral mix 1	Mineral mix	3%	5,050	152
	Total		100%		**3,522**
3	Cassava chips	Gaplek	42%	3,000	1,260
	Soybean meal	Bungkil kedelai	30%	5,000	1,500
	Rice bran	Dedak	20%	2,300	460
	Molasses	Tetes debu	5%	2,000	100
	Mineral mix 1	Mineral mix	3%	5,050	152
	Total		100%		**3,472**
4	Cassava chips	Gaplek	25%	3,000	750
	Copra meal	Bungkil kopra	45%	3,500	1,575
	Molasses	Tetes debu	5%	2,000	100
	Milk replacer	Susu penganti	25%	3,000	750
	Total		100%		**3,175**

Concentrates for weaners of 4–6 months of age

These 16% CP (DM basis) rations are fed at 1.25% LW daily, i.e. 1–1.5 kg/day.

Weaner concentrate can be fed:

- once daily as a supplement to weaners under grazing conditions
- to weaners held in confinement (pens, breedlot, kangang) along with unrestricted forage (such as King grass or corn stover).

If included in a total mixed ration (TMR), mix 25% concentrate to 75% forage.

If the forage quality is low (e.g. rice straw), increase the daily feeding rate to 1.5% LW (e.g. 30% concentrate to 70% forage).

Table 5. Concentrates for weaners of 4–6 months of age

Options	Pakan	Inclusion rate	IDR/kg	Cost of ration
	Bungkil kopra	65%	3,500	2,275
	Gaplek	27%	3,000	810
1	Tetes tebu	5%	1,800	90
	Mineral mix 1	3%	5,050	152
	Total	100%		**3,327**
	Bungkil kopra	52%	3,500	1,820
	Jagung giling	40%	4,000	1,600
2	Tetes tebu	5%	1,800	90
	Mineral mix 1	3%	5,050	152
	Total	100%		**3,662**
	Gaplek	45%	3,000	1,350
	Bungkil kedelai	20%	5,000	1,000
	Dedak	17%	2,000	340
3	Bungkil sawit	10%	1,800	180
	Tetes tebu	5%	1,800	90
	Mineral mix 1	3%	5,050	152
	Total	100%		**3,112**
	Jagung giling	49%	4,000	1,960
	Bungkil kedelai	13%	5,000	650
	Dedak	20%	2,000	400
4	Bungkil sawit	10%	1,800	180
	Tetes tebu	5%	1,800	90
	Mineral mix 1	3%	5,050	152
	Total	100%		**3,432**

Supplements for growing heifers or bulls weighing 130–280 kg

Table 6. Supplements for growing heifers or bulls weighing 130–280 kg

Options	Pakan	Inclusion rate	IDR/kg	Cost of ration
	Onggok	35%	2,000	700
	Bungkil Sawit	59%	1,800	1,062
1	Tetes tebu	4.5%	1,800	81
	Mineral mix 2	1.5%	2,500	38
	Total	100%		**1,881**
This concentrate of about 14.5% CP (DM basis) is fed at 1.5% LW daily to growers eating fresh, green forage (such as King grass or corn stover). When used in total mixed ration, feed at 30% concentrate: 70% forage.				
	Mineral mix 3 at 100 g/hd/day			
	Suitable for growing cattle in SISKA or open grazing systems where:			
2	1. grazing time is not restricted AND/OR			
	2. forage availability is not restricted AND			
	3. estimated forage diet quality exceeds 6% CP			
	Bungkil sawit	80%	1800	1440
3	Mineral mix 4	20%	5750	1150
	Total	100%		2590
Ration fed at 0.5% LW daily (0.5–1.5 kg/hd/day) to growing cattle in siska or open grazing systems where: 1. grazing time is not restricted AND/OR 2. forage availability is not restricted AND 3. estimated forage diet quality is less than 6% CP				

2.9. Energy and protein rations

Concentrates and supplements for pregnant cattle

Table 7. Concentrates and supplements for pregnant cattle

Options	Pakan	Inclusion rate	IDR/kg	Cost of ration
1	Onggok	57%	2,000	1,140
	Bungkil sawit	35%	1,800	630
	Tetes tebu	4.5%	1,800	81
	Mineral mix 5	3.5%	3,750	131
	Total	100%		**1,982**
This concentrate is designed for feeding in breedlot system with fresh, green chopped forage (e.g. King grass or corn stover) Use in total mixed ration feed at 30% concentrate : 70% forage Total mixed ration should be fed ad-lib unless BCS becomes excessive Suitable for both pregnant heifers and cows throughout pregnancy				
2	Mineral Mix 3 at 150 g/hd/**d**			
Suitable for pregnant cows and heifers in 1st / 2nd trimester in siska or open grazing systems where: 1. grazing time is not restricted AND/OR 2. forage availability is not restricted AND 3. estimated forage diet quality exceeds 6% CP AND 4. estimated BCS of cows is at least 3.0 or at least 3.5 for heifers				
3	Bungkil Sawit	80%	1800	1440
	Mineral Mix 4	20%	5750	1150
	Total	100%		**2590**
Feed 1–2 kg/hd/day to pregnant cows and heifers in 1st and 2nd trimester in siska or open grazing systems where: 1. grazing time is not restricted AND/OR 2. forage availability is not restricted AND 4. estimated forage diet quality is less than 6% CP OR 5. estimated BCS of cows is less than 3.0 or less than 3.5 for heifers				
4	Gaplek	44%	3,000	1,320
	Bungkil sawit	44%	1,800	792
	Tetes debu	5%	1,800	90
	Mineral mix 5	7%	3,750	263
	Total	100%		**2,465**
Feed to all pregnant cows and heifers in the 3rd trimester of pregnancy at 0.5–0.75% LW daily (i.e. 2-3 kg/d for 400 kg animal) Feed 0.5% LW when forages are improved pastures such as King grass or higher value crop residues such as corn stover 0.5% LW equates to 20% concentrate: 80% forage. Feed 0.75% LW recommended when forages are lower value crop residue such as rice straw, palm fronds or unimproved pastures, also start feeding in the 3rd trimester regardless of forage quality when BCS of cows in less than 3.0 and heifers less than 3.5. 0.75% LW equates to 30% concentrate: 70% forage. Start feeding at 0.25% LW and increase steadily to target feeding rate over 7 days.				

Concentrates for lactating cattle

Table 8. Concentrates for lactating cattle

Options	Pakan	Inclusion rate	IDR/kg	Cost of ration
1	Onggok	53%	2,000	1,060
	Bungkil sawit	40%	1,800	720
	Tetes tebu	5%	1,800	90
	Mineral mix 5	2%	3,750	75
	Total	100%		**1,945**

This concentrate is suitable for lactating heifers and cows with 3-4 month old calves in a breedlot system with fresh, green chopped forage (e.g. King grass or Corn stover).

The mixed ration of 50% concentrate: 50% forage should be fed ad lib.

2	Gaplek	50%	3,000	1,500
	Bungkil Sawit	40%	1,800	720
	Tetes debu	5%	1,800	90
	Mineral Mix 5	5%	3,750	188
	Total	100%		**2,498**

For lactating heifers and cows with 3-4 month old calves under open or partial grazing systems

Feed at 1–1.25% LW daily (i.e. 4–5 kg/dayfor 400 kg animal)

1.0% LW when forages are improved pastures such as King grass or higher value crop residues such as corn stover. 1.0% LW equates to 40% concentrate: 60% forage

1.25% LW when forages are lower value crop residue such as rice straw, palm fronds or unimproved pastures or cows/heifers are in low BCS

1.25% LW also recommended when cows calve in BCS less than 3 or heifers calving in BCS less than 3.5 regardless of forage quality. 1.25% LW equates to 50% concentrate : 50% forage

Start feeding at 0.25% LW and increase steadily to target feeding rate over 7–10 days.

If concentrate and forage are fed separately, split the concentrate into morning and afternoon allocations.

Concentrates for empty cows

Table 9. Concentrates for empty cows

Options	Pakan	Inclusion rate	IDR/kg	Cost of ration
1	**Mineral mix 3 at 150 g/hd/day** **Suitable for empty cows in siska or open grazing systems where:** 1. grazing time is not restricted AND/OR 2. forage availability is not restricted AND 3. estimated forage diet quality exceeds 6% CP AND 4. estimated BCS of cows is at least 3			
2	Bungkil Sawit	80%	1800	1440
	Mineral mix 4	20%	5750	1150
	Total	100%		**2590**
	Feed at 1–2 kg/hd/day **Suitable for empty cows in siska or open grazing systems where:** 1. grazing time is not restricted AND/OR 2. forage availability is not restricted AND 4. estimated forage diet quality is less than 6% CP OR 5. estimated BCS of cows is less than 3.0			
3	Onggok or Jagung Giling	57%		
	Bungkil Sawit	35%		
	Tetes tebu	4.5%		
	Mineral mix 5	3.5%		
	Total	100%		
	This concentrate is designed for feeding in breedlot system with fresh, green chopped forage (e.g. King grass or corn stover) Use in total mixed ration feed at 20% concentrate: 80% forage			

Supplements and concentrates for bulls

Table 10. Supplements and concentrates for bulls

Options	Pakan	Inclusion rate	IDR/kg	Cost of ration
1	Bungkil sawit **Feed at 0.5–1 kg/day to bulls that are**: 1. not working 2. in good body condition score 3. have unrestricted access to good quality forage	100%	1800	1800
2	Bungkil Sawit **Feed at 2 kg/day to bulls that are:** 1. not working 2. in good body condition score 3. Eating lower quality forage (e.g. palm fronds / rice straw / field grasses)	100%	1800	1800
Bull – working or recovering				
3	**Feed 2–4 kg/day depending on bull's condition** 1. Ration should be: 50% energy source (as rice bran, corn, onggok, gaplek, molasses 50% protein source (as soybean meal, copra, PKC) 2. Must have unrestricted access to good quality forage			

2.10. Land and infrastructure

2.10.1. Land

The requirements for a breedlot are extensive and detailed. See 'Manual for South-East Asian cattle feedlots – LiveCorp' at: *www.livecorp.com.au/LC/files/50/504fc5f1-1b21-4d0f-adaf-44c42d5d7a93.pdf*

Site drainage

The whole yard should be on a levelled surface but with sufficient slope for drainage under heavy rainfall. Where the soil is soft and not free-draining, the yards should be covered with gravel road base to prevent the development of deep mud under cattle movement.

The yard site should provide drainage and a hard base.

Drainage ditches and/or bunds on the upper side of the slope will divert overland flow away from the yard.

Mud pugging will occur during wet weather without a firm, free-draining base.

2.10.2. Facilities

The requirement for infrastructure and facilities will vary greatly between enterprises depending on the size of the operation and herd number. Some operations may have large yards with concrete troughs, steel rails and corrugated iron roofing while another may use wooden railings, atap roofing and plastic troughs.

Any operation that will be based on imported stock under a government program must meet certain ESCAS and OIE standards for animal management.

Important factors include design standards and value for money. Value for money looks at the capital cost, the speed of depreciation or longevity of the structure, and the ease of management and labour costs.

Oil palm plantations are generally well resourced with access roads used during establishment and management of the plantation.

ESCAS is the Exporter Supply Chain Assurance System. See: *http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/information-exporters-industry/escas/auditor-standards-and-checklist*

OIE stands for animal management can be found at: *https://oldrpawe.oie.int/index.php?id=280*

Handling facilities

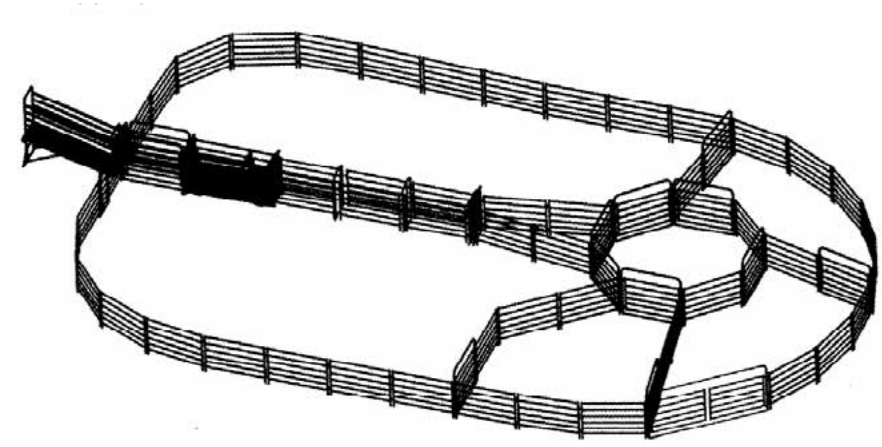
Many operations have a centrally placed cattle yard to which all cattle are delivered and are then used regularly (every 60 to 90 days for one rotation) for selection and drafting of suitable animals and weaning.

There are numerous designs of yards of varying complexity with plans available on the internet. It is best to seek local information for features that have been modified with experience under local conditions.

The main yard should have sufficient area to hold the whole herd with a minimum area of 6 m^2/head. Additional side pens are required for holding drafted sick or injured stock, for weaners and for selected classes of stock.

The design should be finalised before work starts. It should allow immediate use, but also allow for any future expansion of the herd.

Additional ideas for cattle yard designs can be found at: *https://futurebeef.com.au/wp-content/uploads/Cattle_yards_third_edition.pdf*



Stylised illustration of a cattle yard showing loading ramp, race, crush, drafting gates and pens for holding selected animals.

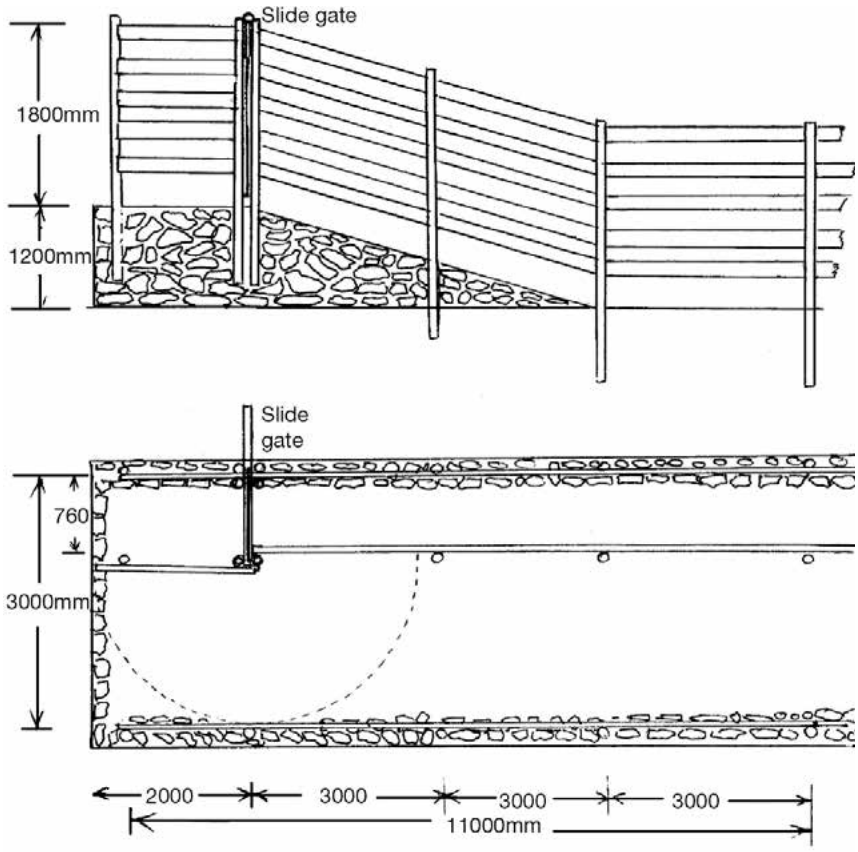
Good unloading ramp level with deck of truck

Cattle jumping from a truck can injure their legs. Unload onto a ramp.

2.10.3. Design basics

Unloading and loading ramps

Unloading ramps allow for organised delivery of relevant numbers of stock from delivery trucks into the yard without the danger of injury to body or leg.



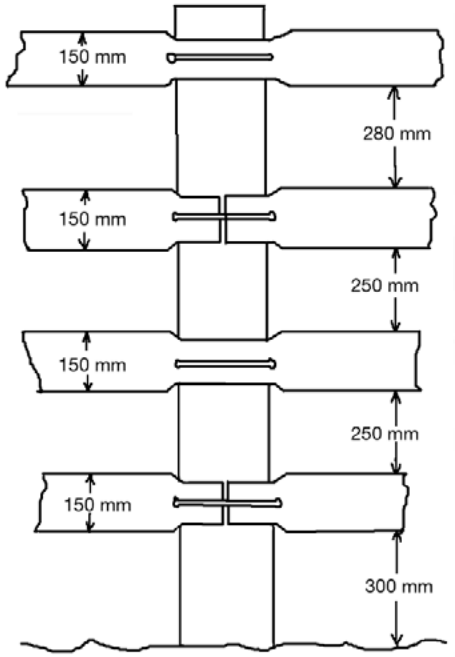
Suggested dimensions for a loading and unloading ramp with adjustable race width (narrower at 760 mm for loading)

Cheaper ramps and sheds may be satisfactory for unloading small numbers of stock but may not endure with time and heavy use.

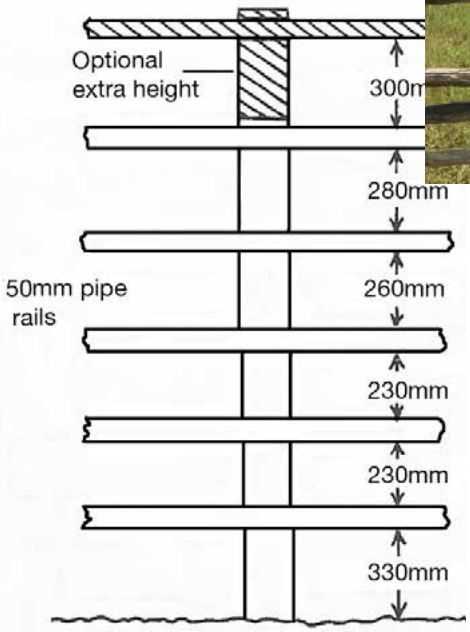
Posts and rails

Posts and railing may be concrete, steel or wood but must be strong enough for holding bulls or mature cows. Wood posts must be of suitably durable timber to last for decades under the local wet and humid conditions. Corner and gate posts in moist areas should be set in concrete for strength with a small sloping apron to shed water away from the base.

Wooden rails and posts cut from forest timber are cheap but not long-lasting.



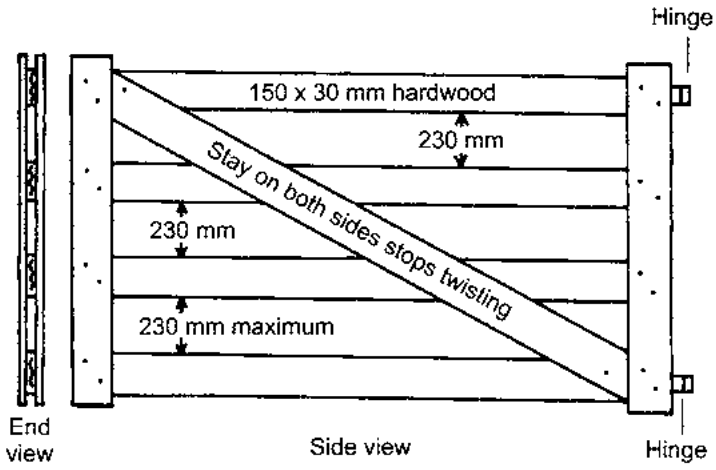
Dimensions for a solid wooden-railed race



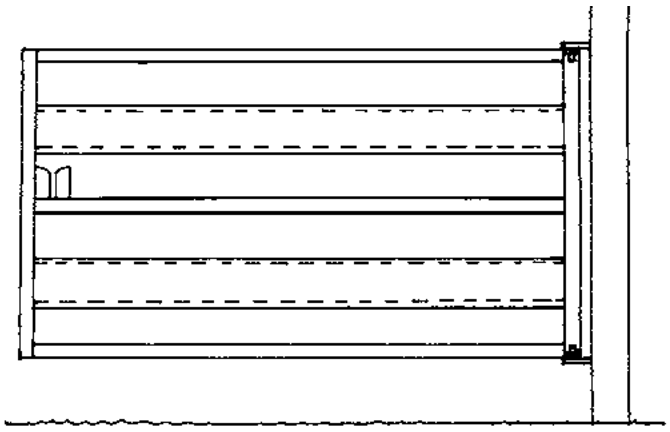
Dimensions for steel or pipe rains

Gates

Sturdy and moveable gates allow stock to be moved between pens and allow stockmen safe exit from aggravated animals.

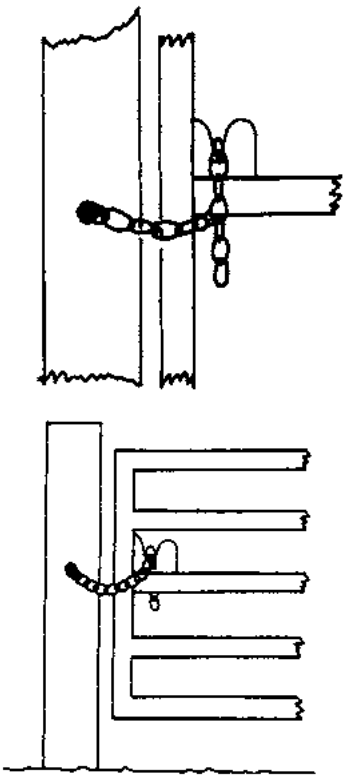


Dimensions for wooden gate



Suggestions for pipe or steel gate

2.10. Land and infrastructure



Cattle-proof gate latches

All gates need robust hinges.

Latches should be able to be opened and locked easily by the stockmen when needed but not by inquisitive animals.

Cattle race

A race of appropriate length will allow sufficient animals to be held for inspection or treatment. The internal width of the race should be 675 to 690 mm depending on the general size (breed) of cattle; this width will prevent animals from turning round in the race.

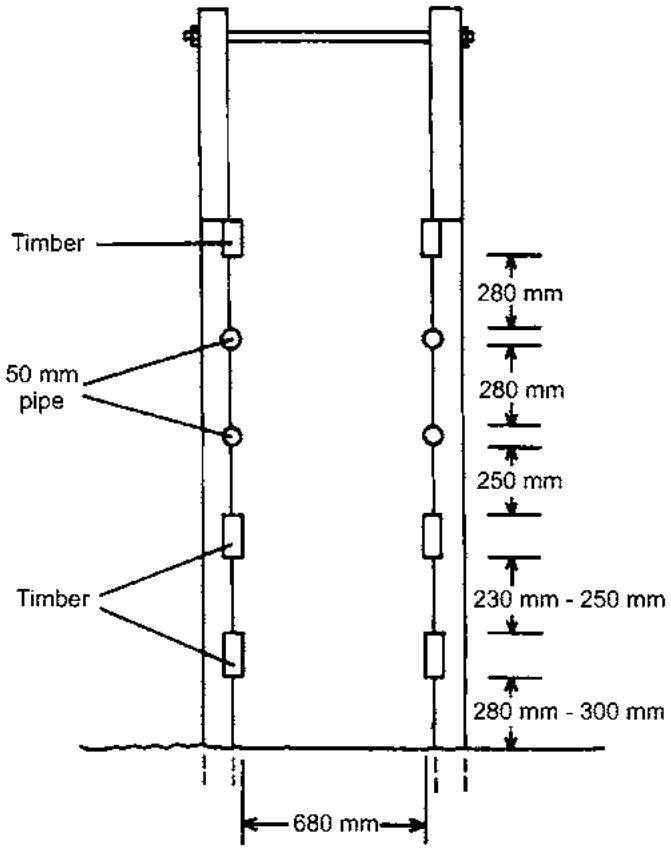
Cattle crush

The race may end in a metal or wooden crush to hold an animal securely for treatment.

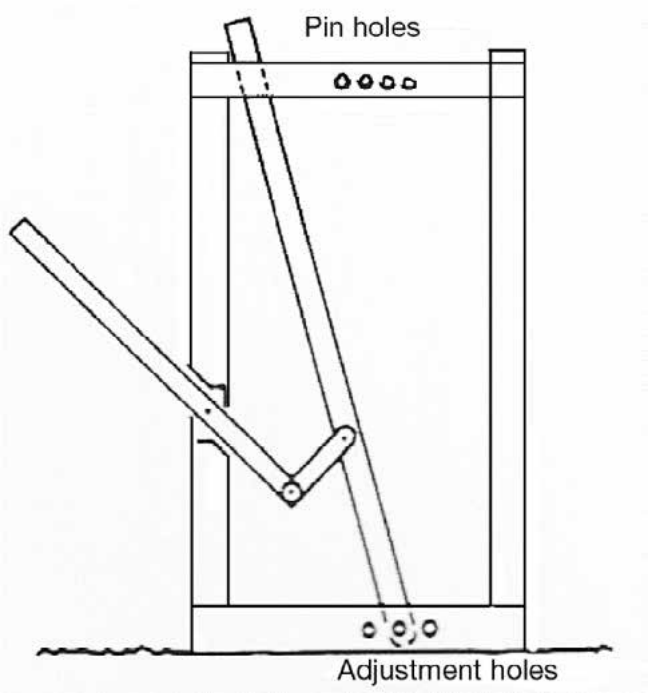
Proprietary designs of crushes with extra features can be checked on the internet. Many steel crushes have hydraulic controls for head restraint; these are excellent for easy handling of large herds – but have an appropriate price.

A wooden locally-made crush may be satisfactory for a small operator in an initial stage of development; a design for a head restraint in the crush is shown.

The race and crush will end with a drafting gate for sorting out selected animals.



Dimensions and railing spacing for a locally-made race



Locally-made neck crush to restrain the animal's head while it is in the crush

A steel crush with sliding gates, side-panels, lever-operated head restraint. A roof protects workers from sun and rain.

Side gates and panels allow safe and easy access for inspections such as pregnancy diagnosis.

Electric fence training wire

A full 3-wire electric fence for training new animals or fresh weaners about electric fencing.
Some yards may just add an offset electric fence wire along an existing railing.

Troughs long enough for access for all stock to prevent bullying of smaller animals

This yard has a concrete apron but with insufficient drainage. Feed is wasted from an open feed trough without a restraining rail.

Movable troughs for feed or water along access road

Troughs

If cattle are to be held in the main or side yards for extended periods, they will need water and food troughs. These should have an extended apron of road base or concrete to prevent mud pugging.

Troughs should be of sufficient length to allow all animals access without dominant individuals chasing away those smaller.

Troughs may be of concrete, wood or plastic but must be guarded with suitably strong rails to prevent stock standing in the troughs.

All food troughs in yards should have roofing to reduce wastage by protecting supplement or forage from rainfall.

Tractors and trailers need access through gates to deliver feed and water. This access will also allow sick or dead animals to be removed quickly.

Troughs in grazing areas

Many forms of supplement will be fed in grazing areas in troughs, often based on plastic drums cut in half.

These feed troughs are usually placed close to roadsides, which are well-drained sites.

Supplement is generally fed in the morning and should be fully consumed before the afternoon rainfall. During periods of extended rain, troughs would need to be covered.

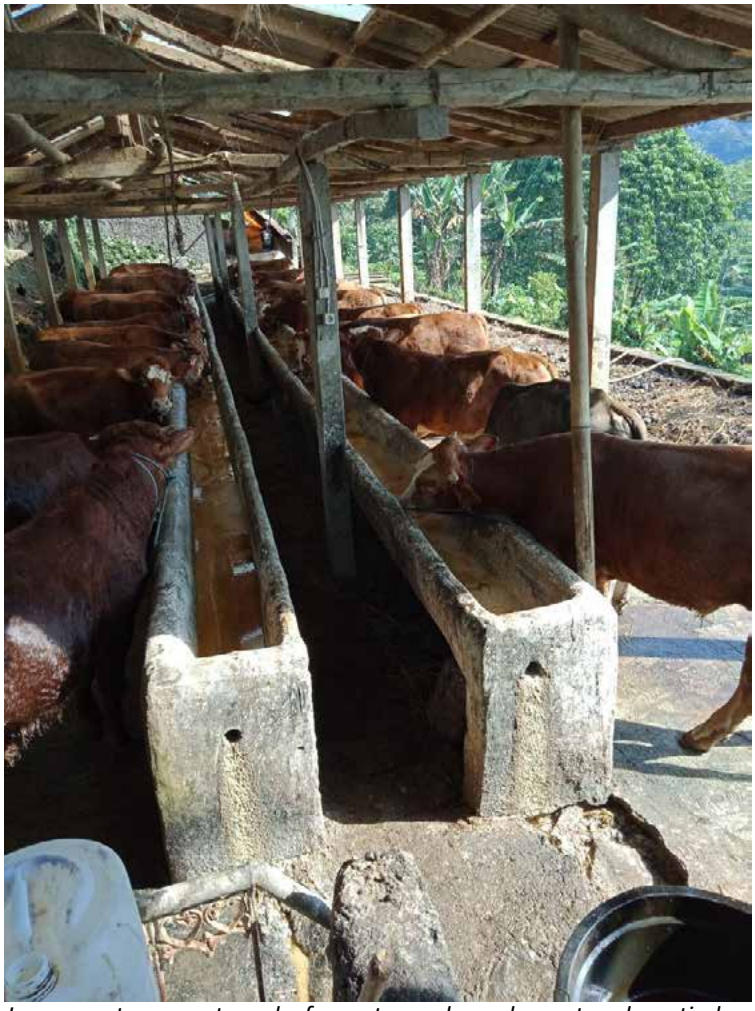
Water supply in grazing areas

Many oil palm areas have numerous naturally occurring water sources – small depressions that hold water and creeks – and with the high local rainfall, these rarely run dry. If these sources fail, water troughs are placed along the roadside fence and filled each day from trailer-mounted water tanks. Troughs are moved each day to the next grazing block.

Paddock water troughs refilled from tanker

Example of feed areas of different cost and standard are shown.

Refer Module 1, Planning, for cattle yard construction notes, and yard designs.



Lower-cost narrow troughs for water and supplement under a timber roof

Wide concrete feeding troughs with guard to prevent stock standing in trough. Note the lower pipe to supplement the original cable guard.

An apron of concrete or road base along the trough will prevent mud pugging.

Portable yards

Portable yards can be moved and set up from area to area. When positioned at the exit of one grazing block, they can be used for early drafting selected animals. While cheaper, portable yards are much less sturdy than permanent railing and would not withstand an excited animal. As with a permanent yard, the enclosure must be large enough to handle selected animals.

Road base may be needed in frequently used permanent yards and around troughs.

Portable holding yard in grazing block

Portable drafting gate

2.10.4. Creep feeding

Creep feeding allows small calves access to higher quality supplements while excluding mature animals. Creep feeding in yards provides small weaners shelter and suitable supplement. Creep feeding of calves grazing with their mothers is based on moveable pens.

Creep pens of wooden construction and shelter protects these weaners.

Creep feed – steel rails prevent cows rreaching calves' high quality ration

2.10.5. Paddock fencing

Fences are used to control stock and pasture management. Electric fences are moveable and are located so that tractors and plantation workers have easy access throughout most of the plantation. Frequently being run along plantation access roadways avoid palm fronds or tall grass that would short out the pulses and reduce battery life.

Permanent paddock fencing often uses barbed wire with live fence posts.

Electric fence running alongside an access road

Fencing usually consists of a powerful portable battery-powered energiser with a single wire supported on insulated fencing posts. Two wires may be used with new cattle unaccustomed to electric fencing.

Permanent paddock fencing of 4 strands of barbed and live fence posts.

Portable electric fencing unit with solar panel

3.1. Pastures

3.1. Pastures (SISKA)

3.1.1. Introduction

In a beef grazing enterprise, the main source of nutrition for the animal is pasture – grasses, legumes and herbs. This section covers important general knowledge about pastures for SISKA systems including nutritional value, the impact of shade and integration options.

This open area under low quality grass would be ideal for developing with improved pastures.

Unshaded roadsides provide grazing favoured by the cattle.

Good pasture growth in an open area between palms

Develop the open areas first

Start planting those open areas with full sunlight, these include open areas within the plantation and under the rows of palms along the roadsides.

About 8% of the area in conventionally configured plantations (with 30 ha blocks) will have more than 50% light transmission because of the road network.

It is rarely economical to develop improved pastures in heavily shaded land under palm. Encourage the natural grasses in these areas to grow well by removing unpalatable weeds, aligning cut fronds in a tight line in the dead palm rows and spreading palm fertilizer across the entire area.

Pasture growing under full sunlight always be more productive than that under the shade of oil palms. Good quality open pastures can be used for weaners, cows with low BCS and to rest bulls. With the right grass and legume mix, no additional protein or energy supplements should be needed although you may still need mineral supplements such as sodium (salt), phosphorus and sulphur.

3.1.2. Grasses

There are many species and cultivars of grass suitable for cattle feed. Grass species may be:

- tall and erect
- decumbent (lie on the ground when the leaf gets long)
- creeping along the ground with stems above (stolons) or below (rhizomes) the ground.

See Section 3.5 Pasture species for more information on potential pasture species.

How good is that grass?

The nutritional value of any grass will depend on its digestibility and on its protein and mineral content.

Digestibility is influenced by the level of fibre in the leaf in the species and by its stage of growth. Grasses that become very fibrous as they mature are indigestible and are not good cattle feed, for example alang alang (*Imperata cylindrica*).

The mineral content of grass leaf will depend on the levels of the major minerals (nitrogen. phosphorus and potassium) in the soil, and this will depend on the basic parent material of the soil or from added fertiliser. Some species can be more efficient at extracting nutrients from the soil and hence be better adapted to the local soil.

For more detail on pasture species see http://www.tropicalforages.info/key/forages/Media/Html/entities/index.htm

Table 1. Typical nutrient concentrations of plucked tips (% of nutrient) of some pasture species growing in a fertile soil

Species	Crude protein	P	K	Ca	Mg	S	Na
Grasses							
Brachiaria decumbens	13.5	0.22	2.65	0.48	0.27	0.22	0.04
Brachiaria humidicola	10.9	0.17	1.68	0.30	0.26	0.19	0.19
Stenotaphrum secundatum	13.2	0.29	1.95	0.60	0.35	0.41	0.56
Paspalum conjugatum	14.4	0.26	2.38	0.60	0.52	0.94	0.02
Axonopus compressus	13.8	0.30	2.09	0.38	0.33	0.29	0.03
Legumes							
Neonotonia wightii	21.3	0.21	1.86	1.25	0.40	0.26	0.03
Leucaena leucocephala	32.1	0.32	2.19	0.94	0.27	0.75	0.01
Desmodium heterophyllum	17.6	1.37	1.03	0.28	0.24	0.04	0.04
Minimum levels of dietary intake for –							
Animal growth	9.4	0.19	0.31-0.43	0.43	0.15	0.17	0.07
Lactation	11–15	0.23		0.32	0.18	0.17	0.10

Whilst all pasture species listed here could keep cattle alive, their good growth requires leaf nitrogen content of 4% or greater. Thus pure grass pastures may still need extra high-quality protein (as from a pasture legume or a protein supplement). Note the high crude protein levels of the legumes – the last three species.

Some species are also low in sodium (Na). Low sodium can be a particular problem in cattle diets in inland regions with high rainfall. Here cattle may crave salt. At most locations throughout Indonesia, cattle will need salt at 50 gm/head/day.

A final factor impacting the quality of a pasture is its density. Pasture grown under heavy shade or heavily grazed pastures have very low density, making it difficult for cattle to physically consume sufficient pasture each day for maintenance and growth. Supplements will be needed in these conditions.

Arachis is a highly nutritious, grazing-tolerant legume.

3.1.3. Why plant legumes?

Legumes generally have higher nutritional value than grasses because Rhizobium bacteria in nodules on their roots can 'fix' nitrogen in the air into protein. Legumes have higher protein and are more digestible than grasses but generally produce lower total yields. The amount of nitrogen fixation is influenced by the levels of available phosphorus (and sulphur) in the soil, by the species and suitable Rhizobium.

Legume species can be:

- twining – vines that grow up and over other vegetation
- erect – upright habit like a small shrub
- shrubs – small trees such as lamtoro, indigofera and gamal
- creeping – low-growing vines that creep under and around surrounding vegetation

Creeping species are more persistent under heavy grazing. Twining species such as Pueraria and Centro have long been used as ground cover in new plantations but can smother young palms. Each species of legume may have a different palatability and digestibility. If it is unpalatable, and is rejected by the grazing animal, it can become a weed.

Stylo – with the small leaf and yellow flower - is adapted to lighter, less-fertile soils.

Shrub legumes such as Indigofera zollingeriana will provide a high protein feed and boost soil nitrogen for the understory grass.

Heavy shading under mature palms severely reduces grass growth.

Weeds invade thin pasture. Lack of good herbage may encourage cattle to eat palm fronds.

Keeping the balance between grasses and legumes

A pasture with 30% legume content will generally have a good balance between the productivity – predominantly supplied by the grass – and quality – predominantly supplied by the legume.

The legume will also supply crucial nitrogen to the grass keeping it growing vigorously, resisting weed invasion and withstanding normal grazing pressure.

As cattle often preferentially graze legumes, sown species must be tolerant of heavy grazing. Creeping legumes such as forage peanuts (*Arachis* spp.) grow low in the sward restricting cattle access.

Some shrub legumes such as gamal (*Gliricidia sepium*) or indigofera (*Indigofera zollingeriana*) persist because their hard stems cannot be grazed by cattle whereas pigeon pea (*Cajanus cajan*) fails to persist under grazing because cattle break off the branches.

As continued excessive grazing will kill any legume, stocking rates must be adjusted appropriately and pastures spelled before being over-grazed.

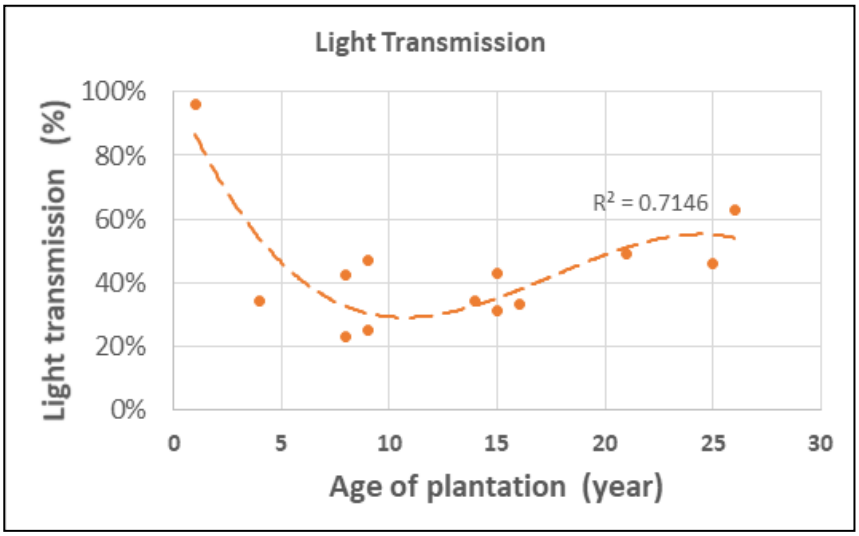
3.1.4. Shade

How much does shade affect pasture quality and production?

As all plants rely on sunlight for photosynthesis and growth, pasture yields decline rapidly as shade increases under growing palms.

Growth of understory pastures declines almost linearly as light is reduced; yields under 60% shade are around half of those of full-sun, and about 20% under 80% shade.

Figure 1 shows the heavy reduction in light transmission through palms from 5 to 16 years old.



(This figure is based on IACCB data from project sites in Sumatra and Kalimantan.)

Heavy shade will reduce photosynthesis in all pasture plants, but light shade may improve the quality of grasses or legumes. Nitrogen level in pasture leaf may increase slightly but most factors of nutritive value decline. Soluble carbohydrates decline while cell wall content (fibre) increases.

The overall effect of shade is to reduce the nutritional value of the pasture in terms of energy, growth and dry matter (DM) content, density and the ability to recover from grazing. Breeding cows will be unable to eat enough and will need supplements to improve their condition during pregnancy and lactation.

Pueraria being planted from cuttings as ground cover

3.1.5. Which pasture species to plant?

Pasture species suitable for oil palm plantations

Pasture development on an oil palm plantation should be phased to improve those areas that can be most productive first. Many plantations have significant areas that are not planted to palm for various reasons, and these areas that receive full sun have the greatest potential for pasture development. They can be planted to highly productive grazed or cut-and-carry species.

Once open areas have been developed to pastures, partially shaded areas should be targeted. These include the many kilometres of roadsides that criss-cross each plantation.

Cover crop of Calopogonium mucunoides supressing weeds under young oil palm

Species for site capture

Several species of legume have been used for many years as ground cover in establishing plantations. These twining legumes include *Pueraria phaseoloides* (tropical kudzu), Centrosema and Calopogonium.

Some creeping grasses can be planted in lines between new establishing palms. At this low population, they are not competing with the young palms but will gradually cover the ground. They can be grazed once the palm fronds are out of reach of the animals. Suitable grasses include the Brachiaria species and *Ischaemum aristatum* (blemblem. rumput padang); suitable legumes include hetero (*Desmodium heterophyllum*) and creeping peanut (*Arachis glabrata*). Productivity of these pastures will decline as the palms reduce light transmission.

Native and naturalised species under mature palms

The heavy shade (low light intensity) under mature oil palms restricts the growth and survival of most species.

Native and naturalised species commonly found under palms include grasses such as T-grass (*Paspalum conjugatum*) and *Ottochloa nodosa*, and erect or twining weedy herbs such as *Chromolaena odorata, Asystasia gangetica, Mikania cordata* and *Mikania micrantha*. Asystasia and Mikania species are readily eaten by cattle and can form a valuable component of the diet – these should not be targeted in weed spraying operations if cattle are being grazed.

Carpet grass (*Axonopus compressus*) is a higher quality species occurring under oil palm, but its productivity is low and it is susceptible to weed invasion even under moderate grazing pressure.

Brachiaria humidicola spreads rapidly with its creeping stolons. It can persist through a relatively long dry season, and recover rapidly once the wet season starts.

3.1. Pastures (SISKA)

Stack palm fronds so as to encourage pasture growth.

Spot spraying weeds using selective herbicides will allow grasses to recover.

None of these native or naturalised pasture species can give good cattle production due to a combination of factors – poor productivity, low nutritive value, anti-nutritional components and susceptibility to weed invasion. However, the productivity and quality of naturalised understory pastures can be improved through regular managed grazing.

More details of suitable pasture species can be found in Section 3.5. Pasture species.

Can I Improve the productivity of naturalised pastures under palms?

Whilst it is not technically or economically viable to develop vigorous improved pastures under established oil palms, the productivity of naturalised understory grasses can be improved with little cost by slight changes to plantation management.

IACCB recommendations to improve naturalised pastures under palms include:

- Lay pruned and fallen fronds in a tight "I"-shaped heap in every second row to minimise the area covered with fronds. (This is in contrast to the standard practice of laying pruned fronds throughout dead alleys ('gawangan mati') and forming "U" shapes.
- Broadcast the standard palm fertiliser across the entire understory area rather than in a restricted circle around each palm or under heaps of decomposing fronds. This will increase pasture growth.
- Manage grazing so that enough leaf is retained after each grazing cycle to minimise the "lag phase" of pasture growth (see Section 3.3 Managing Pastures for details)
- Undertake palm pruning operations immediately before cattle enter each block. Cattle will eat leaflets from freshly cut fronds.
- Spray ferns and other unpalatable species (*Chromolaena odorata*,

Three months after planting this Ubon paspalum (Paspalum atratum) and a range of legumes this paddock is ready for regular light grazing. Once fully established, the pasture will support cattle growth rates of 0.5–0.6 kg liveweight per head per day under careful grazing.

Clidemia hirta, Gleichenia linearis and *Pteridium* spp.) with a selective herbicide such as metsulfuron methyl or triclopyr to eradicate the weeds but retain the grasses.

- Retain palatable plantation weeds such as *Asystasia gangetica* and *Mikania cordata* as these species are readily eaten by cattle.

Note that *Nephrolepsis bisserata* is the host of biological pest control organisms important for oil palms and should not be removed.

It is not economical to spray out weeds in areas where shade is so dense that a moss cover has formed. Grass growth will always be poor in these areas.

Cattle grazing new pasture under young palms

Species for roadsides and other high light environments

Suitable species for grazing include guinea grass (*Panicum maximum*) varieties such as Riversdale and Hamil grass, and Brachiaria species, such as Mulatto, signal and Tully humidicola. These grasses can be planted by seed or rooted cuttings.

Grasses suitable for cut-and-carry production include species from the Pennisetum genus, such as king and elephant grasses. These highly productive grasses require high levels of nutrition to perform at their best. With regular rainfall and fertiliser or manure applications they can produce more than 50 tonnes of dry matter per year.

Ubon paspalum growing in an open area

Does pasture development pay?

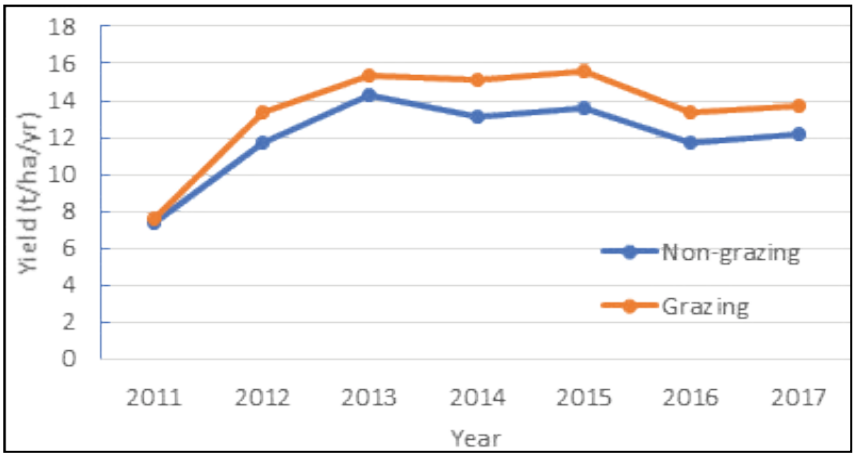
Economics drive the whole cattle operation, the choice of pasture species, method of their establishment and the need for supplements.

Attempts to replace the understory pasture in established oil palm plantations have been consistently unsuccessful. In contrast, management practices that encourage the production of the naturalised grasses have been consistently successful. As a result, it is recommended that improved pasture development be limited to open areas with full sun and moderate to high quality soils.

The costs of production must not exceed the returns from the sale of cattle and from the benefits of controlling vegetation under the oil palms. Returns include profits on the sale of cattle, increases in oil palm yield, ease of harvesting and reduction in the cost of weeding. In some cases, income can also be generated from the sale of urine and manure collected in cattle barns (where these are used for overnight shelter).

Preliminary results from IACCB's research indicates that grazing cattle can stimulate fresh fruit bunch (FFB) production. The graph on the next page shows annual FFB yield for 16 blocks grazed less than twice over a 6-year period, compared with 20 blocks grazed more than 14 times. The grazed blocks were 12% more productive on average. (This preliminary result needs verifying with addition of data from other plantations.)

Figure 2. The effect of frequent grazing on fresh fruit bunch production



3.1.6. IACCB case studies and suggestions for land preparation

Pastures on mined land

Significant areas of land previously mined in Kalimantan could be converted to improved pastures.

In one site in Kalimantan, 10 ha of land was levelled, covered with a 30cm layer of composted fruit bunches and sown to king grass, *Paspalum atratum* and *Indigofera zollingeriana.* As the soil was highly acidic, 10t/ha of dolomite (calcium magnesium carbonate) was spread to raise the pH to around 5.5 to improve plant nutrient availability. Nitrogen (as 100 kg urea /ha) was applied to speed up the breakdown of the empty fruit bunches and as a starter for the pasture species.

The pasture soon became nitrogen deficient except where the *I. zollingeriana* had been planted. For this shrub legume to supply adequate nitrogen to the grasses, it would need to be planted in rows 5 m apart and would also need extra phosphorus. Phosphate fertiliser (triple super-phosphate -TSP or double super-phosphate - SP-36) was applied to the rows of legumes in a 1m band at a rate of 500 kg/ha (effectively 100 kg/ha over the entire area).

These fertilised areas will be grazed by weaners at a stocking rate of 3–5 weaners per ha to provide growth rates of 0.5 – 0.65 kg/head/day. Twice-yearly applications of urea and heavy application of kandang manure (10tonnes/ha/year) will still be required by the grasses, depending on legume growth and the acidity of the soil. Soil pH will be checked regularly as heavy applications of urea will acidify the soil. Additional lime or dolomite to raise pH to above 4.8 may be required.

New pastures under new palms

When establishing new palms, plantations often sow legume cover crops to prevent soil erosion, loss of soil organic matter and incursion of weeds, retain soil moisture, build soil nitrogen and attract beneficial insects. Typically, phosphate fertiliser is applied at 500 kg/ha (TSP or SP36) to promote strong growth of the legumes.

The most commonly used legume cover crops and their seeding rates are:

- *Calopogonium caeruleum* (1–1.5 kg/ha)
- *Calopogonium mucunoides* (1–3 kg/ha)
- *Pueraria phaseoloides (Pueraria javanica)* (3–4 kg/ha)
- *Mucuna bracteata* (0.2–0.3 kg/ha)

Whilst *Calopogonium caeruleum* is the most shade tolerant of these, it is a poor quality, unpalatable forage and is not recommended for plantations where cattle might be introduced. *P. phaseoloides* and *M. bracteata* are good-quality forage legumes with moderate shade tolerance.

Weaner cattle can be introduced to lightly graze the cover crops once the oil palms are 2–3 years old but must be removed if they start eating oil palm leaves.

Pasture grasses could be sown when palms are being planted. Seed of *Paspalum atratum* should be planted in a 1.5–2 m wide strip at 10 kg/ha (effectively 2 kg/ha of oil palm) as early as possible after clearing and 3–4 weeks before planting the legume cover crop.

P. atratum is a moderately high-quality pasture grass with moderate tolerance to shade and also to wet and acid soils. If the grass establishes sufficiently, it should gradually spread to form a useful pasture from about three years old until the palms are about 8 years old and shade starts to severely limit productivity.

For more information on P. atratum see: http://www.tropicalforages.info/key/forages/Media/Html/entities/paspalum_atratum.htm

Pastures in open swampy areas

Oil palm plantations commonly have unused, poorly drained areas that can be planted to highly productive improved pasture species adapted to the wet conditions. Adapted grasses include the high-quality para grass (*Brachiaria mutica*), hymenachne (*Hymenachne amplexicaulis*) and aleman grass (*Echinochloa polystacha*). Both hymenachne and para grass have potential to invade wetland areas and should not be planted adjoining water courses or where overland flow will facilitate their spread to non-target areas. Humidicola grass (*Brachiaria humidicola*) also tolerates relatively wet conditions and heavy grazing pressure. Shrub legumes such as *I. zollingeriana* and turi (*Sesbania grandiflora*) are well-adapted to the wet.

3.2. Establishing pastures

3.2. Establishing pastures

Mechanical and manual preparation for a nursery

Chemical weed control before planting

3.2.1. Planning for planting pasture

1. Select the best areas for maximum benefit (soils, full sunlight or light shade).
2. Decide which pasture species are best for the local conditions.
3. Prepare soils for nursery with cultivation or herbicide 3–6 months before planting planned grazing areas or buy seed (which may have to be imported).
4. Apply NPK fertiliser to nursery area.
5. Apply lime or dolomite to raise the pH of strongly acidic soils.
6. Apply cattle manure or composted empty fruit bunches at a rate of 10 tonnes/ha if soil organic matter is low.
7. Plant selected species and allow to cover the nursery over 3 to 6 months.
8. Prepare land for planting on grazing areas during this time.
9. Dig out plants or cut stolons, cart to new area for grazing.
10. Plant cuttings by hand or machine.
11. Allow to establish well (3–6 months) before first grazing.

3.2.2. What special pasture areas will I need?

You will need areas of improved pasture for young animals after weaning, as hospital paddocks for young cows and working bulls to recover their body condition and, if land is available, pastures for fattening yearling stock. These improved pastures can be planted from seed or from cuttings.

What is a nursery paddock?

Nursery areas are planted with the selected pasture species as a source of planting material for the grazing area of the plantation. Prepare the area with a tractor or by hand.

Where and when should I plant the nursery?

When grass cuttings are to be used for pasture development, the nursery should be close to the areas being planted as there will be a considerable volume of material to move.

Ideally, plant the nursery at least 6 months before starting the pasture development program.

What size area should I plant?

The area of the nursery paddock should match the size of the first three to four months of field planting. A well-established nursery can be used to plant an area about 20 times its size and should recover for the next round of planting in three to four months.

Once the first paddocks have been planted, further areas can be planted progressively with a small area every day over an extended period.

Preparing nursery by ploughing and harrowing

Prepare the seed bed using machinery or manual labour. A good seed bed has:

- cultivated soil with fine tilth at the surface
- complete removal of weeds and other plant competition
- a full profile of soil moisture.

3.2.3. Planting from cuttings

Preparing grass cuttings for planting

Establish an efficient system for collecting the grass cuttings in old fertiliser bags and for transporting this bulk. Organise appropriate tools or implements for quick and easy planting.

What are hospital and weaner paddocks?

Special paddocks of vigorous, palatable herbage should be planted and reserved for young stock to recover from sickness or from the effects of weaning. Younger weaners will continue to graze these improved pastures while being fed appropriate supplements.

Common grass species that include *Brachiaria, Stenotaphrum* and *Panicum* will require regular topdressing with NPK fertiliser for good growth. Adding legumes such as *Arachis* will improve nutrition quality but will require adequate phosphorus fertilising (but not extra nitrogen fertiliser).

What are grass and legume fodder banks?

Areas of fodder grasses and of legume are maintained to provide plenty of good quality cut-and-carry fodder for penned young or sick stock. Common grass species include king grass or odot (dwarf king grass) and *Panicum* with *Indigofera* as a harvestable legume.

Grasses and/or legumes can be established vegetatively (from cuttings or runners) or from seed. The choice of species selected may well depend on the ease and reliability of establishment.

How do I prepare the area for new pasture?

Establishing pastures ideally requires similar ground preparation to that for common crops to achieve best results.

Planting cuttings or runners requires less overall soil disturbance than for spreading seed.

Harvesting and preparing grass cuttings

The seedbed is cultivated to remove existing vegetation and weed.

Establishing pasture from cuttings or runners

1. Establish large enough nursery as source of new planting material
2. Prepare area for new planting by:
   - light cultivation
   - weed control or
   - heavy trampling of wet soil
3. Wait for sufficient rain to saturate the soil.
4. Apply suitable NPK fertiliser and composted manure or empty fruit bunches if required
5. Organise transport for cuttings from nursery
6. Prepare cuttings.
7. Plant cuttings by hand about 30–50 cm apart.
8. Allow cuttings to root securely (about 3 months) before first light grazing

3.2. Establishing pastures

Heavy trampling of wet soil for one or two days can develop a seedbed.

Extra watering and fertilising with a slurry of manure will improve establishment of grass cuttings.

Lines of Stenotaphrum cuttings being planted by hand

The plant material is inserted into the soil at intervals of 30–50 cm using a mattock or mechanical planter. Rainfall is reliable, these plants should start growing and spreading immediately.

For and against hand planting

Hand planting requires:

- adequate source of vegetative material from a nursery
- more hand labour for planting and carting of relatively large volumes of green material
- less initial need to control weeds because the pasture plants thicken more quickly.
- estimates for hand planting are about 50 m^2 per person per day.

Where to plant

Plant in sunlit areas, in open areas and along the roadsides.

Planting grass cuttings under established palms has been unsuccessful in IACCB's experience

Cuttings (or seed) of shade-tolerant gasses and legumes can be planted along roadsides where there is sufficient sunlight penetration.

Land along roadsides in established palms can be cultivated mechanically as long as the root system of the palms is not disturbed. Do not cultivate more than 10cm deep to avoid palm roots.

As cultivation may disturb the root systems of established palms, other methods of land preparation include:

- Spot spraying with glyphosate to kill all vegetation in metre-wide spots or rows, generally with further applications at 2 weeks intervals. Cuttings of grasses and legumes can be planted into the bare spots with the dead sprayed vegetation providing ground cover during establishment.
- Applying a 10 cm thick layer of mulch 1 metre wide in a strip along the roadsides. The mulch – generally of ground palm fronds – suppresses weed growth and provides an environment for establishing cuttings.

Mechanised planting

Planting species vegetatively can be mechanised by harvesting the cuttings or runners with a mower or loosening the soil surface with a cultivator. The bulk material is loaded onto a trailer with a fork lift and then spread by hand from the trailer over the new area that has been worked with a disc harrow. The disc harrow is then used again to partially bury the planting material. A final pass with a rubber tyre roller will ensure good soil contact with the cuttings.

3.2.4. Planting with seed

The seedbed has to be better prepared when planting with seed. It needs a finer surface for the small seed and better weed control because the seedlings establish much more slowly than do cuttings.

These conditions are commonly achieved at the time of planting oil palms and are also used to plant cover crops such as Pueraria phaseoloides (locally known as P. javanica) or Mucuna bracteates.

For and against planting with seed

Planting from seed requires:

- more soil disturbance – generally with machinery but also from heavy trampling
- weed control to protect the small seedlings.
- source of viable seed – which may have to be imported
- much faster coverage of area
- spreading by machine or hand – light grass seed is difficult to spread evenly by machinery
- suitable machinery.

Planting from seed requires better soil disturbance to provide a seedbed. This disturbance will also help to control any existing weeds that would compete with the new seedlings. Cultivation should not be deep (not more than 10cm) to lessen soil erosion or damage any palm surface roots.

Small pasture seeds spread over the surface are soon buried between soil particles by raindrops; with continuing soil moisture and suitable temperature, they should germinate quickly. Growth from seedlings is comparatively slow but the plant population is higher than with spaced cuttings.

Note that fertiliser spinners will spread pelleted NPK in a band up to 10 metres wide. Most grass seed is light and may spread in a band only 3 metres wide; larger legume seed spreads an intermediate distance.

Grass seed should not be left mixed with NPK fertiliser under humid conditions as the acidity may spoil germination.

Grass seed (Brachiaria Mulato)

Seed of grass and legume is mixed with NPK fertiliser before spreading.

Seed can be spread by hand over small areas but spinners are much faster.

3.2.5. How good is the seed?

Pasture seed of the chosen species must be tested for viability and purity (good germination, no dormancy, weed-free).

Seed testing may be done by a seed-testing laboratory for certified verification. Local testing may involve spreading a number (say 100) seeds on damp blotting paper on a dish. This may be covered with another layer of damp blotting paper and the dish left in a humid area for about 7 days. At the end of the test, lift the top paper and count the percentage of seeds that have germinated.

Grass seed may have to be imported (for example from Australia or Thailand). Newly harvested grass seed is often dormant for a few months, and must be stored under dry conditions to maintain viability and prevent damage from vermin.

Brachiaria species usually require a period of 6 months storage before the seed will achieve a high germination percentage. Seed quality will

Legume seed (here Pueraria javanica) is hard and easier to spread than lighter grass seed.

start to deteriorate if seed is stored in hot or humid conditions.

Ideally, grass seed should be planted within 18 months of being purchased.

Legume seed of some suitable species is often available within the south-east Asian region where it is often hand harvested.

Legume seed is hardier under storage than grass seed but a percentage may be dormant. Dormancy may be broken by mechanical abrasion of the seed coat, or by heat or acid treatment.

Breaking legume seed dormancy

Dormancy in legume seed can be broken in various ways by:

- allowing the seed to flow slowly onto a sanding disc spinning at moderate speed
- allowing the seed to flow over a heated metal plate
- stirring some concentrated sulphuric acid onto the seed, then wash the seed after 5 -10 minutes and dry

(Note. Concentrated sulphuric acid – battery acid – is highly caustic and should only be used under supervision.)

Some legumes need to be inoculated with specific Rhizobia for adequate nitrogen fixation; this specific inoculant can be purchased but it should be stored in a refrigerator to be applied immediately before sowing, and kept out of sunlight.

All improved grass pastures on infertile soils are going to need regular application of NPK fertiliser to remain productive (but only P, K and S for legumes).

3.3. Managing pastures

Establishing palms are generally weeded around their base. The weeded area may be reduced to a 1.5 m radius.

Managing new pastures

- Control weeds as pasture spreads and thickens – do not allow weeds to dominate.
- Do not graze until pasture is well established
  - at least 3 months from cuttings
  - at least 6 months from seed
- Do not graze until pasture is at least 10 cm high
- First grazing should be light and even
- Periodic weed control after all grazing
- Graze pasture evenly by frequent rotation of blocks.

See Section 3.2 for more information about establishing pastures

3.3.1. Early weed management

Weeds are often a major problem in newly establishing pastures because they grow faster than the newly-sown species. Existing weeds can be controlled mechanically before planting slightly by light cultivation, or well with a total herbicide such as glyphosate. Operators of knapsack or machinery sprayers must not allow herbicide to fall or drift onto the young oil palms or the establishing pastures.

Some hand weed control may be needed against creeping weeds that threaten to smother young oil palms. Woody weeds may require a combination of slashing with a machete and application of herbicide.

An open paddock of improved grass for special purposes

3.3.2. Specialist pastures in SISKA systems

Nursery paddocks

Nursery areas are planted with the selected pasture species as a source of planting material for the plantations. Ideally, nursery areas should be planted at least 6 months before starting the pasture development program.

The area of the nursery paddock should match the size of the first three to four months of field planting. A well-established nursery can be used to plant an area about 20 times its size and should recover for the next round of planting in three to four months.

If grass cuttings are being used for pasture development, the nursery should be close to the areas being planted. Once the first paddocks have been planted, further paddocks can be planted progressively with a small area every day over an extended period. An efficient system must be established for rapid collection of grass cuttings in fertiliser bags, for transport and for appropriate tools or implements for quick and easy planting.

A fodder bank of napier grass for cut-and-carry

Hospital and weaner paddocks

Special paddocks of vigorous, palatable herbage may be planted and reserved for weaners. If there is sufficient area, these improved pastures could also be used for other individuals or groups that need special care or additional nutrition.
If this intensive grazing area is close to the kandang, additional nutritional supplements could be fed each night in the yard if needed. Common species are *Brachiaria*, *Panicum* and *Paspalum* with extra fertilising for good growth.

Grass and legume fodder banks

Areas of fodder grasses and of legume are maintained to provide good quality cut-and-carry fodder for penned young or sick stock. Common species include napier grass and *Panicums,* and are heavily fertilised.

SISKA grazing systems

The rotational grazing system used for SISKA is based on block grazing in which cattle are moved daily around an area of oil palm plantation. In Central and South Kalimantan where the land is relatively flat, the block is a rectangular shape of 30 ha; on undulating land in Sumatra, a block may be an irregular shape of 5 to 15 ha.

Depending on cattle numbers and the quantity and quality of feed available, this rotation around the blocks takes between sixty to ninety days.

Oil palm plantations range in size from 5,000 to 30,000 ha but not all of this area is available for grazing due to topography. Very steep sites cannot be grazed while geographic features may make cattle management difficult, for example in areas prone to flash flooding.

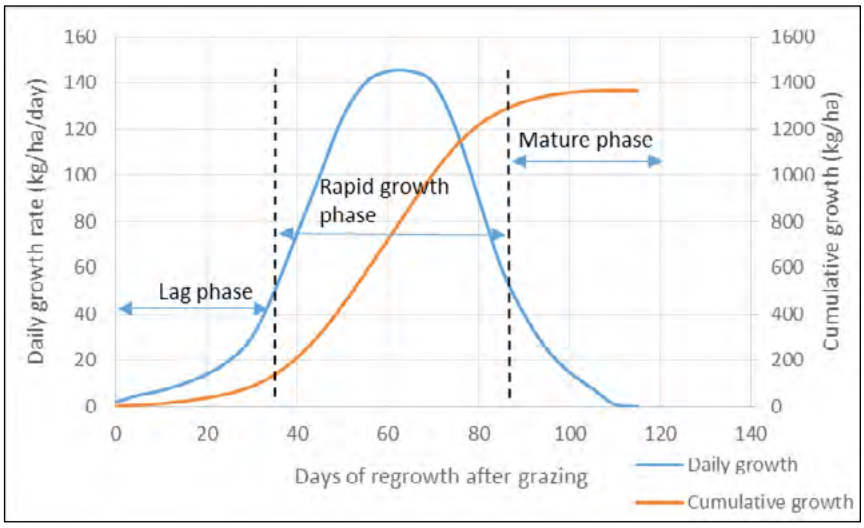
Ripe palm fruit (FFB) are harvested weekly or on a 10–15 day cycle as bunches ripen throughout the year. Bunches are lopped and immediately carried to the roadsides for collection. Cattle are not encouraged to eat or spoil FFB.

3.3.4. Grazing management

Grazing management is achieved by controlling the stocking pressure (numbers of beasts per area) and by moving large numbers of cattle continually onto new blocks.

This heavy rotational grazing is used under the palms to control vegetation for ease of harvesting FFB and to prevent patch grazing where cattle concentrate on selected areas.

The speed of rotation around the blocks is based on the feed available on a block rather than adjusting the number of animals in the group each day.



Quality and quantity change through phases of grass growth

SISKA integration – oil palms, access roads, cattle and electric fencing

After grazing, cattle are moved to the next block to allow grass to recover

Rested pasture ready for grazing

Cattle will eat and spoil fresh fruit bunches (and palm frond) if there is insufficient pasture.

Estimating available feed before grazing

Cattle are moved on so grazed grasses can put out new leaf to intercept all the sunlight available and so maximise regrowth. Grazing starts again as soon as pasture growth starts to slow and the plants starts to mature and become less digestible.

Moving cattle between blocks on a daily or two-day basis also helps to keep cattle more manageable and allows stockmen to check for problems from injuries or sickness as they pass through gates.

Forcing cattle to eat all the herbage present under very heavy rotational grazing limits their ability to select their diet; this will reduce milk production in mothering cows, weight gains in growing cattle and recovery in cows after weaning.

Cattle should be moved to fresh feed each day or even twice a day where the area being grazed is too small for the number of cattle. This is to ensure that areas are not overgrazed and cattle are forced to eat palm fronds and even Fresh Fruit Bunches (FFB).

Available feed can be estimated using a quadrat before cattle are moved but they are normally kept in each block for a whole day, rather than being moved throughout the day.

Stocking rates

Carrying capacity is an estimate of how many cattle can be grazed on an area without affecting their production or ruining the pasture. It is currently estimated at four hectares of plantation per beast. Stocking rates show how many cattle are actually grazing the pasture resource whether above or below the carrying capacity.

Stocking rates are based on the number and type of cattle per unit area. To standardise an animal, types of cattle are classified as Animal Equivalents (AE) based on their weights and production levels.

Table 1. Recommended stocking rates with Adult Equivalents based on the size of the animal, the age of the plantation

Oil palm plantation age				5–9 yr		10–15 yr		15–20 yr		20–25 yr	
Grazing intensity (ha/AE)				Low	Max	Low	Max	Low	Max	Low	Max)
Light factor differences				1	1	0.7	0.7	0.8	0.8	0.8	0.8
Stock category	Approx age (months)	Approx weight (kg)	AE	Recommended stocking rates (hectares/AE)							
Dry cows	18+	350 +	1	7	4	4.9	2.8	5.6	3.2	5.6	3.2
Wet cows	30+	380 +	1.5	10.5	6.0	7.4	4.2	8.4	4.8	8.4	4.8
Bulls	24+	450 +	1.5	10.5	6.0	7.4	4.2	8.4	4.8	8.4	4.8
Weaners	3–6	80–120	0.6	4.2	2.4	2.9	1.7	3.4	1.9	3.4	1.9
Growers	7–12	120–250	0.75	5.3	3.0	3.7	2.1	4.2	2.4	4.2	2.4
Yearling heifers	12–18	220–340	0.85	6.0	3.4	4.2	2.4	4.8	2.7	4.8	2.7

Table 1 shows recommended stocking rates with Adult Equivalents based on the size of the animal, the age of the plantation (and hence the pasture growth under the canopy).

For practical purposes, this table is a guide to the numbers of animals that should be ordered when first stocking the oil palm plantation. It is based on the type and size of the animals, and whether the plantation plans are to graze heavily to control herbage levels or to seek better performance from the cattle.

High stocking rates reduce the growth rates or weight gains of each individual animal but may increase the production per unit area. The balance is that the individual animal must be able to grow well enough to reach a saleable weight or, in the case of a breeding enterprise, must be able to produce frequent healthy calves.

The key to pasture management under the SISKA system is to maintain a stocking rate at which the breeding cattle can reproduce efficiently while also meeting the management requirements of the oil palm plantation.

Palm fronds stacked to allow cattle good access to pasture

Palm frond management

Mature palm fronds are cut periodically to improve access to new FFB. The cut fronds are often placed between the palm rows but this limits access to pasture by the cattle. Also when they walk across lines of cut fronds, they can become lame in the hoof from spines.

It is now recommended that fronds are heaped to allow stock to cross.

Electric fencing power box and solar panel

Fencing

Electric fences offer a flexible and low-cost option for managing cattle in oil palm estates. They have the important benefit of being easily removed so as not to impede normal plantation operations.

Cattle are restrained to the current grazing block by moveable electric fences. Electric fences apply high voltage but low current; this provides an instant shock but does not damage the animal's nervous system. (Commercial power is medium voltage (120–240 volts) but with high and dangerous current.) Electric fences need two wires for novice cattle, but only one for well-trained stock.

Plantations normally use a consistent block size of 15–30 ha. Most plantations have two sets of fencing – one for the paddock currently being grazed, and a second for the next paddock to be grazed. The second fence is erected while cattle are grazing within the first.

Fences run down the roadsides and block boundaries. These laneways are generally clear of tall grasses that might otherwise short out the electric fence.

Fence wire is coiled onto a spool after each use so that the wire can be easily rolled out for the next use.

Insulated spools for winding electric fencing wire

Training cattle to electric fences

Training cattle to respect the electric fence is an essential step in their successful use. Weaners should be trained in a secure yard with a stand-off electric wire erected about 15cm from the rails. Weaners, and newly imported heifers and bulls) quickly learn to respect the electric fence. However, an electric fence is not sufficient to keep newly weaned calves and their mothers apart.

Tips for good electric fencing

- Ensure that the wire does not foul against herbage or other materials that will cause it to earth.
- Maintain good conductivity throughout the fencing system by always using the correct wire or cable. High-powered energizers require large capacity of wire or cable. NEVER use household electrical cable that is made for low voltage (110–240V) use only.
- Regularly check the current of the fence with a fault finder meter to make sure that there is no fault along fence lines.
- Joining a cut wire. For good conductivity through the connection, separate the metal strands by melting a strip of plastic thread with a lighter/match approximately 50 mm from the ends of each length. Pull the end off the plastic, being careful not to break the steel wires. Tie both ends of the wires together and then twist the steel wires together.
- Store coils of wire in a dry area and away from fertilizer, lime, acids and other chemicals. Avoid dropping wire onto stony or abrasive surfaces that can damage galvanizing. Take care not to bend any wires in the coil as this makes it difficult to unwind.
- Do not run electric fence wires for any distance parallel to telephone wires or power lines as this may cause interference.
- Maintain the insulators in good condition. Poor quality insulators can cause problems of interference which are difficult to trace.
- Make sure that the electric fence earth is as short as possible, is separate from all other earthing systems, and is routed away from communication lines or cables.

Two wire electric fences are normally used with novice stock to minimize the risk of break-outs. Once cattle are calm and trained, a single wire is generally adequate.

Little pasture growth, usually of T-grass, under mature palms

Ongoing grazing management

In larger paddocks or blocks, pastures should be managed to prevent patch grazing as cattle will concentrate on selected areas where the herbage is sweeter, and reject more mature herbage. Under oil palms, heavy rotational grazing is used to control foliage for ease of harvesting FFB, and to prevent patch grazing.

Experience has shown that no 'improved' grass can survive under the low light intensity of a more mature oil palm plantation. In most plantations, the main surviving grass species is T-grass (*Paspalum conjugatum*). Under shade, it is stemmy but with leaves 15 cm long and about 7mm wide. While not over productive, it survives, is edible and forms a matt under grazing, so protecting the soil surface slightly.

When cattle are moved out of a grazed area to a new block, they noticeably go straight to more palatable grasses in the open area along the roadside.

Good pasture growth under less shade with younger palms

Cattle moving into a new block relish new grass on the roadside

Pasture under palms before grazing

Pasture under palms after grazing must be allowed to recover.

Weed grasses in a pasture are difficult to control except possibly by improving soil fertility with fertiliser or manure.

Spraying broad-leaf weeds with selective herbicide does not kill the underlying grasses.

Many herbicides are being tested for control of different weeds.

3.3.5. Weed management

Weeds can be a major problem in reducing the quantity and quality of herbage available for the livestock.

Weeds are plants that the grazing animals will not eat and thus they can become dominant under excessive grazing pressure.

Some weeds are poisonous to cattle or humans; others can cause physical injury through spines or thorns.

Grass weeds may be rejected by cattle because the leaves are too fibrous or are unpalatable. Examples include *Eleusine indica* and alang alang.

Eleusine indica and T-grass (*Paspalum conjugatum*) can become dominant on waste land. Weed grasses are difficult to control except possibly by improving soil fertility with fertiliser or manure – improved species are more responsive.

Grass weeds are more difficult to control because the most suitable herbicide (for example glyphosate) usually kills all grass and other species leaving a bare patch that is often colonised by the fastest establishing species – usually new weeds.

Weeds can be controlled by hand or with herbicides. Hand weeding is labour intensive but may be needed around establishing palms. Many plantations routinely spray any inedible weeds remaining after grazing cattle have been moved to another paddock.

There are many herbicides available that can be applied using knapsack sprayers or motor-driven sprayers. In both cases, operators should wear protective clothing, masks and footwear even though this can be most uncomfortable under hot and humid conditions.

Broad-spectrum or selective herbicide?

Herbicides may be selective or broad-spectrum. Selective herbicides will control many broad-leaf weeds without affecting the grass; broad-spectrum herbicides can kill all green plant material that is contacted. Many weeds have become resistant to some herbicides and this will affect the local choice of chemical.

Most herbicides (as amine salts) are soluble in water; formulations (as esters) are soluble in oil and are generally used against woody species.

Many plantations have a problem with woody broadleaf weeds especially *Clidermia herta* which can be a very aggressive colonizer on opened land. Spot spraying with broad-spectrum herbicide can kill the undergrowth of grasses leaving a bare patch that is soon colonized by new weeds.

More selective herbicides such as Triclopyr will kill the woody weeds without affecting the pasture species. Metsulfuron-methyl is also effective against woody weeds but may kill some annual grasses. Use of these selective herbicides integrates the management of palms and cattle.

3.4. Soil fertility and pasture selection

3.4.1. The fertility of your soil

The natural fertility of a soil depends on its parent material and the degree of leaching of plant nutrients over the ages under local rainfall conditions. In Kalimantan, rainfall may range between 2500 and 5000 mm per year.

While young volcanic soils are often fertile, in the wet tropics most soils are highly leached, low in nutrients and acidic, with the low pH locking up much of any available phosphorus and othr nutrients.

Immediately after a forest is cleared, there may be moderate fertility in the surface layer organic matter, but high soil temperature and high rainfall will soon reduce fertility to its basic level.

The soil types of IACCB partners in Kalimantan are classified as alluvial, kambisol, podzolic and oxysols. In general, these soils are acidic with pH ranging from 3.5 to 5.5-6 (H2O method).

Typical soil analyses from an Indonesian laboratory for two soils are given below. For each soil, there is a surface analysis – 0-30cm, and a sub-soil analysis – 30-60cm. The analyses provide both chemical and physical information.

Soil texture

The soil texture profile gives an indication of the water-holding capacity of the soil. Sands are very free-draining, whereas clay soils are prone to waterlogging. Loams generally provide a good balance in terms of water-holding capacity and drainage.

Physical analyses of two Kalimantan soils (Figure 1) show the percentage of sand, loam and clay in two soil samples; they are classsifed as 'loam'.

Figure 1. Soil texture analysis

Depth	Soil Texture		
(cm)	**Sand (%)**	**Silt (%)**	**Clay (%)**
0-30	39.4	38.0	22.6
30-60	40.8	36.0	23.2
0-30	37.8	31.2	31.0
30-60	36.8	32.0	31.20

The soils from the test locations are loams although most of the soils in South Kalimantan are sandy loams.

Chemical analysis

The key chemical factors of two Kalimantan soils taken at two depths (Figure 2) are pH, levels of organic carbon and of phosphorus, the total cation exchange capacity and the aluminium concentration.

Figure 2. Soil chemical analysis

Depth	**pH**	**pH**	**C-Organic**	**N total**	**C/N**	**Extrc P**	**Exchangeable cations (meq/100g)**				**CEC**
(cm)	**(H2O)**	**(KCl 1M)**	**(%)**	**(%)**	**ratio**	**Bray (ppm)**	**Al+H**	**K**	**Mg**	**Ca**	**meq/100g)**
0-30	4.85	3.80	1.12	0.22	5.09	0.14	3.94	0.36	1.40	1.91	8.00
30-60	4.73	3.75	0.89	0.11	8.09	0.25	5.26	0.15	1.08	1.38	8.50
0-30	4.69	3.80	0.87	0.12	7.25	0.16	3.12	0.10	1.08	2.48	6.39
30-60	4.88	3.75	0.65	0.10	6.50	0.05	4.50	0.10	0.97	2.06	7.10

In both soils, the pH is below 5 so they are described as acidic. In acid soils, aluminium becomes soluble and will combine with any phosphorus, making the phosphorus and many other soil nutrients unavailable to plants and so retarding root growth.

The organic matter content (see C organic in Table 2) of a soil has a strong effect on its capacity to retain both moisture and nutrients. Soils with less than 1% carbon are low in organic matter. Note that the organic carbon levels in Table 2 are below 1%. Their cation exchange capacity (CEC) is often <10 MEQ, and their aluminium saturation can be above 50%.

The availability of soil phosphorus (P) is strongly influenced by pH and the inherent level of P; the levels in these soils is extremely low.

Most legumes require >15ppm soil P to persist. A combination of liming and fertiliser application would be required to bring these soils up to a satisfactory fertility level for most vigorous tropical pastures or be planted with species that are tolerant of acid soils.

The growth of any plants (palms or pastures) will be determined by this underlying soil fertility and can be improved by applying macro-nutrients (nitrogen. phosphorus and potassium) as mineral or organic fertiliser.

Rates of fertiliser application for pasture establishment and for pasture maintenance each year are best determined by trial and experience, and by cost. The benefit derived from applying lime (calcium) to a tropical soil to reduce soil acidity should be investigated locally.

Preparing soils for pastures can be a challenge for those without experience, and it is recommended that an experienced crop agronomist, with knowledge of the soils in your particular area, is engaged when getting started with pasture development.

Pasture species tolerant of acid soils
(Above) Brachiaria humidicola
(Below) Indigofera zollingeriana

3.4.2. Selecting pasture species

Species for very acid soils

Native grasses such as T-grass (*Paspalum conjugatum*) often are the first to colonise acid soil areas due to their tolerance of soil acidity. The productivity of all vegetation on acid-infertile soils will be low, but, a few species are more tolerant than the average.

Brachiaria humidicola is one of the few highly productive and moderately nutritious grasses that will grow on the acid-infertile soils of Kalimantan. In these conditions, its productivity and quality will be lower than if grown in a more fertile site.

Indigofera zollingeriana is also highly tolerant of acid-infertile soils, remaining green and productive even on mined land in South Kalimantan. Additional species are listed in the section on pasture species.

It is advised to test a range of grass and legume species at any new site as small changes in climate, soil nutrients and pH can have a significant impact on the productivity of pasture species.

NPK (Nitrogen, Phosphorus, Potassium) fertiliser is applied for palm growth and yield – and to improve quality and yield of existing pastures.

3.4.3. Critical plant nutrients

Critical levels of soil macronutrients (nitrogen, phosphorus and potassium) are essential for good plant growth and for good cattle growth. Sulphur can be included as a macronutrient because it is often added in large amounts. Calcium is applied as lime or dolomite and may be in some fertilisers. Calcium levels determine the acidity (pH) of the soil and so the availability of other nutrients.

Nitrogen

Nitrogen in soil is found in organic matter and is fixed from atmospheric nitrogen by symbiotic bacteria in root nodules of many legumes.

Inorganic N can be supplied as urea, diammonium phosphate (DAP) or monoammonium phosphate (MAP), sulphate of ammonia or as a nitrate. (Ammonium nitrate has the highest concentration of N but maybe prohibited locally as it can become explosive). Urea can be as prills (solid pellets) or in aqueous solution. It is soluble and breaks down when wetted releasing ammonia; if urea is not buried into the soil, this ammonia may be lost to the atmosphere with little benefit to plants. Urea can be incorporated by drilling into the soil behind a cultivator. However, in established pastures it is generally only possible to apply urea by broadcast methods. Applying high rates of urea will make the soil more acid, requiring the application of lime or dolomite to correct the change in pH.

A deficiency of nitrogen is indicated by slow leaf growth and pale green colour; increasing the supply of nitrogen will improve grass growth and also improve protein content of the leaf.

Phosphorus

Phosphorus comes from the soil's parent material. It is only slightly soluble but may have been leached from the soil by eons of tropical rainfall. In very acidic soils, phosphorus is locked up chemically and becomes unavailable to the plant.

Phosphorus can be applied to the soil as superphosphate (which also contains 11% sulphur) or as triple super (with little sulphur). It is also a component of DAP and MAP. The P in rock phosphate is less available to plants but is rendered more available by soil acidity. Phosphorus is not highly mobile in the soil and surface applied P will not move down the soil profile to deeper plant roots; it can be lost when fertilised soil is eroded by heavy rainfall.

The pale colour of this stylo may well indicate sulphur deficiency.

Phosphorus deficiency is often indicated by small seedling leaf with a purplish colour.

Potassium

Deficiency is often indicated by marginal necrosis (leaf edges die and turn brown). Examples of deficiency are commonly seen in potted house plants that are not fertilised.

Sulphur

Sulphur deficiency is generally noticed as pale green leaf in legumes because the Rhizobium bacteria need sulphur to fix nitrogen. Most legumes will grow poorly if the soil is deficient in sulphur and no sulphur

fertiliser is applied. A rate of 5 kg/ha of elemental sulphur may be sufficient. Note that several NPK fertilisers may contain sulphur – single superphosphate contains 10% S. A few legumes, such as *Indigofera zollingeriana*, appear to be tolerant of low sulphur levels.

Test a possible sulphure deficiency by dressing a strip with a fertiliser containing sulphur e.g. gypsum or single superphosphate.

Calcium

Calcium deficiency may be indicated by other mineral deficiencies associated with acid soils. The heavy rates of lime (tonnes per hectare) applied in temperate countries to promote clover growth are rarely appropriate for highly acid soils – think in terms of kg rather than tonnes.

The establishment of lines of calcium-loving legumes such as leucaena can be boosted by heavy local application of lime or coral sand, but generally leucaena does not grow well on acidic red soils such as are commonly found in Kalimantan. In some regions, more alkaline soils lie underneath the acidic surface soils. Where leucaena is able to get its roots into these alkaline subsoils, growth can be reasonable. Liming of the surface soil at a rate of 10t/ha will greatly help with establishment. This can be done in 50cm wide strips along the rows of leucaena so that the actual amount of lime used is reduced to around 1 t/ha. The lime should be incorporated to the greatest depth possible (generally up to 20cm) by ploughing.

Micronutrients

Micronutrients may be deficient for some species with deficiency of copper, cobalt or zinc indicated by unusual leaf formation or discolouration. Magnesium deficiency has been identified by frond discoloration in oil palms in Malaysia. Molybdenum is needed by the Rhizobium bacteria in some legumes for good nitrogen fixation. Cattle may also suffer from some micronutrients on some soils; deficiency symptoms of cobalt may include poor growth or poor hair colour.

Manure

Manure from animal pens is a good source of organic matter and plant nutrients but large and heavy applications (10 to 20 t/ha) are needed to supply adequate nutrients. This can be labour-intensive unless mechanised.

Manure should be allowed to compost (rot down well) for a period of months to allow fibres of straw or stem to breakdown. Manure full of undecomposed leaves or straw may take up nitrogen from the soil for months rather than releasing it to plants. Check that the compost is fully broken down for up to 3 months. Breakdown can be speeded up by applying urea to the compost at a rate of 1kg urea to 1 m^3 compost.

Kandang manure must be allowed to compost for some months.

Kandang manure spread over napier grass

NPK spread with a fertiliser spinner over the whole understory will also improve growth of the grazing animals.

3.4.4. Placement of artificial fertilisers

Artificial fertilisers can be applied in a variety of formulations or forms. Formulations include nutrient mixes such as NPK or compounds as described above, e.g. diammonium phosphate. Forms include granules (NPK), prills (urea), crystals (KCl) and powders (gypsum).

All fertilisers can be spread by hand but the form of the fertiliser will affect the evenness and width of distribution from a fertiliser spreader or spinner.

Traditionally NPK has been spread in a fairly tight circle around each palm tree by hand. Establishing palms are weeded around the base and the fertiliser placed in that circle. This method also allows the plantation manager to check on workers' efficiency. However, the tight circle of NPK reaches only the palm roots close to the trunk.

When cattle are being grazed under the growing palms, it is preferable to broadcast the fertiliser over the whole area using a fertiliser spinner.

The advantages include:

- faster operation with less labour
- more even coverage to the whole root structure of the palms
- boost to the pasture growing under the palms, improving the quality and quantity of the pasture
- improved growth of the grazing animals.

Fertiliser should applied soon after cattle are moved out of a block to allow it to be dissolved before cattle are reintroduced. Cattle can die from urea poisoning if they eat urea from a thick band around a palm.

3.5. Pasture species for oil palm plantations

3.5.1. Pasture species for open areas and under palms

Which pasture species?

Alang alang – a tall vigorous grass with very low quality

Different species have different adaptation to soil fertility and soil moisture (including drainage). Some tall vigorous species may grow well only on high fertility soils, and would not be suitable for grazing on infertile hill soils.

Grass and legume species can be characterised by their:

- growth form – tall, erect or creeping
- response to soil fertility
- persistence under grazing
- response to light intensity (shade)
- response to poor drainage
- digestibility.

Tall species include elephant grass and guinea grass, creeping species include *Brachiaria* and *Stenotraphrum*. Tall grasses that grow on poor soils but have low digestibility include alang-alang (*Imperata cylindrica*). Paragrass (*Brachiaria mutica*) thrives on soils with poor drainage.

Stenotaphrum – a low creeping, highly digestible grass

Legume species can be shrub-like (*Indigofera*, *Leucaena* or some *Stylosanthes*), or climbing (*Pueraria*, *Centrosema*) or low growing (*Desmodium canum, D. heterophyllum, Arachis*).

Most pasture species will grow well under full sunlight but those most adapted to heavy shade under oil palms are likely to be less productive.

Some pasture plants can be planted vegetatively from clumps or runners, others can be planted from seed if it is commercially available.

Only local testing and experience will determine suitable species for any particular environment or management system.

Kacang pinto – low creeping legume that tolerates heavy grazing

Indigofera – a tall shrub legume for cut-and-Scarry

3.5.2. Grass species

Brachiaria decumbens (BD or signal grass)

Brachiaria decumbens is locally known as BD. It is a vigorous, perennial grass with broad adaptation to tropical environments, and has been widely used across the humid tropics as a preferred permanent pasture species. It withstands heavy grazing, is highly productive under intensive management, but also persists on low fertility, acid soils. BD seed is relatively low cost as it produces good seed yields. Under heavy grazing, BD can combine with creeping legumes, especially *D. heterophyllum*, but it can smother many twining legumes under lighter grazing. It is intolerant of poor drainage.

Signal grass (BD) is widely adapted to Indonesian conditions, can be very productive and withstands heavy grazing.

Nutritive value and animal production

BD has moderately high nutritive value with intermediate to high digestibility (50–80%), but this is greatly dependant on the fertility of the soil. Its crude protein content ranges from 5 to 20% depending on soil fertility and the age of the leaf. Crude protein content of leaf harvested at 30 days was 10% but only 5% at 90 days. Adding a creeping legume such as *Desmodium heterophyllum* will increase the nitrogen concentration of the grass.

Young cattle, sheep and goats might develop photosensitisation when being grazed only on BD.

Heavily fertilised pastures can be highly productive (up to 1,300 kg/ha liveweight gain) due to the high yields of herbage and its ability to carry high stocking rates. On more fertile soils with a reasonable legume component, gains of 0.45–0.60 g/head/day for individual cattle and 400–600 kg/ha/yr are commonly achieved.

Environmental requirements

BD is grown in the humid tropics and warmer subtropics (preferably with annual rainfall exceeding 1,500 mm), but can stand a dry season up to 5 months. BD stays green well into the dry season (better than *B. brizantha*). It can tolerate some short-term flooding but not temporary waterlogging (where *B. humidicola* is superior).

It is moderately tolerant to shade and is suitable for ground cover under more open plantations – it is well-suited to mature coconuts or roadsides in oil palm plantations. Shade reduces its tolerance of heavy grazing.

Soil requirements

BD grows on a wide range of soil types including those of low fertility, low pH (as low as pH 3.5) and high aluminium saturation. It is also moderately tolerant of manganese. It does not respond to lime when grown on acid soils. BD has finer and longer roots than some other *Brachiaria* species, providing superior uptake of P and N from the soil but it is less frequently grown on heavy clays subject to waterlogging.

Establishment and growth

Large areas can be easily planted with the large, free-flowing seed. Seed is frequently dormant for 6 months after harvest and should be stored or scarified before planting. Seed is broadcast at a rate of 3–4 kg/ha, then lightly harrowed and rolled. It is commonly planted with a range

of forage legumes such as *Desmodium heterophyllum* (hetero), *Arachis pintoi, Stylosanthes guianensis* and *Centrosema pubescens.* Of these, only hetero and pinto peanut tend to persist in the vigorous BD sward. Centro and stylo are generally productive for a year or two before being smothered.

BD can also be planted from rooted sprigs or vegetative sets (leaf with rhizomes) although it does not spread and cover new land as quickly as *B. humidicola*. Sprigs planted on 1m centres generally form a cover in 3 to 4 months.

Mulato grass (*Brachiaria* hybrid)

Recently established Mulato grass that will thicken up with more rainfall.

Mulato grass is a cultivated hybrid of *B. brizantha* x *B. ruziziensis* with broad adaptation to tropical environments. Mulato is a taller and more vigorous than BD but requires good soil fertility for high cattle production. It is high-yielding, producing 10–25% more dry matter than *B. brizantha* or *B. decumbens*. Dry season production is also relatively high, although it is not as tolerant of dry conditions as species adapted to the dry tropics.

The yield and viability of its seed is generally low.

Nutritive value and animal production

Mulato has excellent nutritive value with cattle gaining up to 0.9 kg/head/day for short periods in Honduras. In Colombia, crude protein content and *in vivo* dry matter digestibility were 13% and 70% respectively for 90 day regrowth, and 11% and 71% respectively for 168 day regrowth.

Environmental requirements

Mulato grass is adapted to the moderate to high rainfall tropics, with annual rainfall of 1,000–3,500mm and short dry seasons. In the tropics, it grows to altitudes of 1800m. Shade tolerance is similar to *B. brizantha*, but lower than buffalo grass (*Stenotraphrum*).

Soil requirements

Mulato needs well-drained soils of medium to high fertility with pH 4.5–8.0 but can grow in less infertile acid soils with high Al. It responds strongly to added N on deficient soils.

Establishment and growth

Cv. Mulato can be planted from seed into a well-prepared seedbed at 4–6 kg/ha seed. As freshly harvested 'Mulato' seed remains dormant for several months, seed must be stored or acid-scarified before planting. It can be planted vegetatively from stolon cuttings. It establishes rapidly, achieving 85% ground cover at 2 months, and can be lightly grazed after 3–4 months

Brachiaria humidicola (BH, humidicola, koronivia)

Brachiaria humidicola is locally known as BH in Indonesia. BH is a strongly stoloniferous perennial grass, forming a dense ground cover. BH is grown widely in humid-tropical countries of South America, the Pacific Islands and south-east Asia, and in coastal regions of northern Australia as a permanent pasture for grazing and as ground cover for control of erosion and weeds. It is adapted to low fertility soils, is easy to establish from cuttings, has excellent ability to suppress weeds and maintains good ground cover under heavy grazing. However, its nutritive value is lower than that of BD.

BH – aggressive spread from cuttings, good cover on acid soils, better feed value with heavy grazing

Nutritive value and animal production

Although the leaf appears hard and fibrous, nutritional value is relatively good (5–17% CP) considering the low fertility of the soils in which it is often grown. Digestibility declines quickly if not grazed.

BH is slightly less palatable than many softer grasses, but readily eaten by cattle when kept short and leafy. However, its palatability on extremely acid-infertile soils can be low as the leaf blade becomes fibrous and strongly pigmented with anthocyanin.

Cattle growth rates of 0.4-0.5 kg/head/day are commonly achieved over extended periods. In humid tropical Vanuatu, steers grazing humidicola/legume pastures gained 0.74, 0.68 and 0.55 kg/head/day at stocking rates of 2, 2.5 and 3.5 head/ha, respectively, over a two-year period. However, much lower production was recorded in Colombian savannas with liveweight gains of 0.22 kg/head/day and 240 kg/ha/yr from pure swards of BH. Production increased to 0.37 kg/head/day and 402 kg/ha/yr when BH was grown with *Arachis pintoi*.

BH recovering from heavy grazing during the dry season

Environmental requirements

BH needs 1,000–4,000 mm of reasonably well-distributed annual rainfall, being less vigorous in environments with less than 1,600 mm annual rainfall and a dry season longer than 6 months.

BH grows best in full sunlight but has moderate shade-tolerant (as under mature coconut plantations) but is less shade tolerant than buffalo grass (*Stenotaphrum secundatum*).

Soil requirements

BH grows on a wide range of soil types from very acid-infertile (pH 3.5), high Al soils, to heavy cracking clays, to high pH coralline sands. It grows well on infertile soils with low P levels, but will respond to N and P. BH is tolerant of poor drainage and is often found on seasonally wet clays. It is considerably more tolerant of waterlogging that BD.

Establishment and growth

BH is favoured by many smallholders with grazing land because it establishes reliably and spreads rapidly from stem cuttings planted at 1 m x 1 m spacing. Larger areas can be planted by spreading stolons over cultivated soil and lightly incorporating with disc harrows.

Seed can be used for larger commercial plantings. Seed is broadcast at 2–8 kg/ha (depending on germination percentage) onto a well-prepared seedbed and lightly harrowed. Freshly harvested seed may be dormant for 6 months and should be stored before planting. Seed quality will decline rapidly if stored inappropriately and this has been the cause of many planting failures.

BH performs best under moderate to heavy grazing pressure, and will maintain good ground cover even under very heavy grazing due to its strongly stoloniferous growth habit. Under light grazing, the dense mat of decumbent leaves and stems, associated with humid conditions, forms a bulk of low quality herbage.

BH is very aggressive, forming a dense bulk of herbage that will generally out-compete weed species. It is thus not compatible with most forage legumes, but can combine well with creeping legumes such as *Desmodium heterophyllum* under moderate to high grazing pressures.

Dry matter production is strongly influenced by soil fertility and ranges from 7–34 t/ha/year with a linear response to nitrogen. In Fiji, unfertilised humidicola grass (BH) produced an annual DM yield of 11 t/ha DM but this increased to 34 t/ha with the application of 452 kg/ha N. In humid-tropical Vanuatu, annual yield declined from 28 t/ha DM to 17 t/ha DM as fertility declined. Annual DM yields of 7 t/ha and 5–9 t/ha were reported from Paraguay and Brazil, respectively.

Humidicola can be very aggressive if ungrazed when it will compete against established palms for soil nitrogen.

Stenotaphrum secundatum (buffalo grass)

Buffalo grass – established only with cuttings, good shade tolerance, good cover with adequate rainfall

Stenotaphrum secundatum, known as buffalo grass in the Asia-Pacific region, is a stoloniferous perennial, forming a dense leafy mat to about 20 cm. It is very shade tolerant (growing well under more open stands of coconut palms), forms a thick ground cover, is tolerant of poor quality soils and salt, and withstands heavy grazing. It forms dense turf when regularly mowed or grazed, but is susceptible to weed invasion during periods of extended drought or excessively heavy grazing.

Nutritive value and animal production

Buffalo pastures are mainly used for breeding cattle as its quality is not high enough for fattening. Long-term steer gains are generally 0.25–0.4 kg/hd/day in humid-tropical locations unless planted with a high-quality legume such as Leucaena or pinto peanut.

Buffalo grass is less productive than other higher yielding species, commonly producing 3–5 t/ha in typical grazing environments but reaching 8t/ha. Importantly, it maintains its yield down to 40% sunlight.

Environmental requirements

Buffalo grass commonly grows in areas with rainfall from 1,000 to 2,000 mm in the humid tropics and subtropics although it will colonise moister situations in areas down to 750 mm and as high as 3,500 mm. While moderately drought tolerant, it prefers good moisture, and can withstand temporary flooding and waterlogging.

Buffalo grass grows best between about 20°C and 30°C. It is among the more shade tolerant tropical grasses (grouped with *Brachiaria subquadripara, Axonopus compressus* and *Paspalum conjugatum*).

Soil requirements

Although commonly found on siliceous and calcareous sands near the sea, it also grows on a wide range of well or poorly-drained soils, from sandy loams to light clays. It can be found in infertile to moderately fertile

soils with pH from 5.0 to 8.5 (calcareous sand), and has good tolerance of soil salinity (to 15 dS/cm) and of wind-borne salt from the sea.

Establishment and growth

Buffalo grass is propagated vegetatively as seed is not commercially available. It is planted from rooted sprigs/stolons dug from an established pasture either by hand or with an end loader. Hand planted buffalo grass can be planted into herbicide-treated or cultivated areas. Under oil palm plantations, it can also be planted under pruned palm fronds to protect it from grazing stock. Sprigs planted in a 1m grid pattern normally form a complete cover in 6 months, but denser planting will accelerate cover.

To establish a buffalo grass nursery, plant sprigs in a 30 cm grid pattern to achieve cover in about 3 to 4 months. A well-established nursery will provide sufficient stolons to plant 20 times the nursery area.

Mechanised planting can be done by collecting stolons with an end-loader, then spreading from the back of a trailer or with a manure spreader. Once spread, the paddock should be disced and rolled. Using this method, 10 ha can be planted from 1 ha of stolons.

Buffalo grass is rarely found with other grasses as it is able to form a dense mat. It combines well with legumes such as *Desmodium heterophyllum, D. heterocarpon* subsp*. ovalifolium, D. incanum, D. triflorum* and *Desmanthus virgatus*. It has also been planted with hedgerows of *Leucaena leucocephala* on coastal coralline plains.

Ischaemum ciliare (syn *I. aristatum, I. indicum*, Batiki blue grass, rumput padang)

Batiki blue grass is a tufted or spreading stoloniferous perennial, rooting freely at the lower nodes, and forming a dense mat under regular defoliation. It provides permanent pasture and good ground cover with rapid spread from cuttings giving good competition against annual weeds after soil disturbance or clearing of forest. It gives moderate but stable production on poor soils on sloping land.

Nutritive value and animal production

The leaf is soft and of reasonable nutritional value although production is likely to be limited on low fertility soils. CP values range from 18% in 10-day regrowth, to 14% at 3 weeks, 11% at 6 weeks, 8% at 8 weeks, and 6% or below in mature foliage. Average IV (*in vivo*) digestibility of 5-week regrowth is 59%. It is palatable, readily eaten and tolerates heavy grazing. It requires regular defoliation since quality declines rapidly with age of regrowth. It is generally effective as a weed suppressant unless constantly overgrazed.

Liveweight gains of 0.4–0.5 kg/head/day have been recorded during the growing season, but can drop to zero in cool/dry periods. Milk production is poor in dairy cattle, and even with supplements, only 6–7 kg/head/day is achieved a stocking rates of 3–4 cows/ha. Higher productivity is achieved with more rapid grazing rotation. In Samoa, LWGs of steers grazing a pasture of *Ischamemum indicum* were 220 kg/ha/yr; steers on *I. indicum* with *Desmodium heterophyllum* gained 370 kg/ha/yr.

Environmental requirements

I. ciliare grows well in the wet lowland tropics especially between 30 and 35ºC and has good flood tolerance. It is moderately shade tolerant

remaining productive and persistent with light transmission as low as 40%. It has poor drought tolerance and no cold tolerance.

Soil requirements

Adapted across a wide range of soil textures (except sandy or coralline soils). It is especially useful on very acid, low-fertility soils with high Al, and can tolerate poor drainage and some salinity.

Establishment and growth

Batiki bluegrass is normally established vegetatively to give rapid ground cover and to suppress weeds. Runners can be broadcast onto the soil surface and disced in, or planted on a 30 cm grid. Seed production is unreliable because of the high rainfall conditions. Seed shows dormancy for up to 6 months after harvest, with germination continuing to improve for up to 10 months under good storage conditions. Seedlings are vigorous.

If ungrazed, *Ischaemum* will compete with associated coconut palms for N and P. Leaf growth and crude protein respond to low levels of applied N, but response declines with increasing levels. Responses to P have been measured in associated legumes, but not in the grass.

Dry matter yields are around about 10 t/ha DM under high rainfall but will depend on fertiliser application. *I. ciliare* is a competitive grass suppressing most weed species, although it combines well with the low-growing legumes such as *Desmodium heterophyllum* and *D. triflorum* under grazing.

Hyparrhenia rufa (thatch grass, called Nepal grass in South Kalimantan)

Nepal grass – tall tufted grass of medium quality, useful dry season reserve, spreads from seed

Hyparrhenia rufa is a coarse, perennial grass, but sometimes grows as an annual. It is variable in form, but usually forms dense tufts of stems from a short rhizome. The stems can be 0.3m to 3.5m tall with leaf sheaths enclosing the stem at intervals, making it appear banded. The leaf blades are 30–60 cm long. The panicle is up to 80 cm long.

The rough-haired seeds are dispersed in the coats of animals, on the wind, and on vehicles and machinery such as graders. H. rufa can be used as thatching, as straw, and as pulp for making paper. It is planted as a border grass to prevent erosion, and can be spread by roadside graders.

Nutritive value and animal production

H. rufa is sometimes grown as a forage and fodder for livestock in some drought-prone environments where other more favourable species fail to persist. It is generally of low nutritive value, particularly at the end of the dry season, but can be useful where no alternatives are available. Due to its low nutritive value, *H. rufa* is generally supplemented with legumes to increase protein content, as well as with molasses, citrus pulp, or bran for energy.

Flowering stems have sparse leaves, but grazing increases leaf production.

The main value of H. rufa for Indonesian cattle farmers is as a dry season emergency forage when other available forage sources have been depleted. Whilst its nutritive value is acceptable during the growing

season, when cut as a dry season forage it should be considered as being of similar value to freshly cut rice straw. Crude protein generally ranges from 2–6%.

Environmental requirements

In its native range the grass grows in woodlands and seasonally flooded grasslands. It readily naturalizes disturbed habitats and is regarded as an invasive species in several countries, including Australia. *H. rufa* is well adapted to annual wildfires.

Paspalum atratum (*P. plicatulum*)

Paspalum atratum, commonly referred to as atratum, is a leafy upright perennial tussock grass, usually less than 1.0 m tall, and growing to 2 m when in flower. It has wide, shiny leaves and is tolerant of moderately heavy shade, making it useful in agroforestry systems. Atratum cv. Ubon is used as a sown forage or hedgerow in areas extending from near the equator (south-east Asia) to the subtropics of Australia, USA and South America.

Atratum is easy to sow from seed and quick to establish. It is adapted to wet, acid soils, and is tolerant of flooding. It is palatable to cattle, horses and sheep and tolerates close grazing, but is unpalatable when mature.

Atratum – easy to establish from seed, moderately tolerant to poor drainagewaterlogging and shade, palatable when young

Nutritive value and animal production

Atratum has in vivo dry matter digestibility of 50-68%, with mean crude protein content of 11%. It is well eaten by cattle, buffaloes, horses, fish, and pigs and there are no records of anti-nutritional factors.

Atratum is a moderately high-quality forage grass, supporting liveweight gains of 0.6 kg/day LWG over a 168-day season in pastures stocked at 6 yearlings/ha. Higher gains have been achieved when grown with a legume. Mature atratum is not readily eaten by cattle.

Cultivars of the related species *P. plicatulum* previously selected in Australia for good agronomic features were not regarded as high quality feed as the mature leaves are high in fibre and have sharp edges.

Atratum has commonly produced dry matter yields of 10-15 t/ha/yr DM and up to 26 t/ha/yr DM.

Ubon atratum growing vigorously

Environmental requirements

Atratum naturally occurs in areas with rainfall 1,500-2,000 mm/yr. In cultivation, it is best with over about 1,500 mm, being less drought tolerant than *Brachiaria decumbens* or *B. brizantha*, but still surviving dry conditions reasonably well. It will grow in low places subject to waterlogging but not permanent inundation.

Atratum is adapted to areas with average annual temperatures as low as 20°C, but is best grown between about 22 and 27°C.

Soil requirements

Atratum grows well on soils ranging from sands to clays, and can tolerate poorly drained, acid, low fertility conditions. It survives at low fertility but responds to nitrogen applications of the order of 150–200 kg/ha/yr N.

Establishment and growth

Atratum establishes readily from seed or rooted sprigs/stolons. Seed is normally sown at 2–5 kg/ha, either broadcast or in 0.5–1 m rows.

Atratum can compete with aggressive species such as *Paspalum notatum* cv. Pensacola, even under heavy grazing. It has moderate shade tolerance and can be grown under trees. Atratum combines well with legumes such as *Arachis pintoi*, *Calopogonium mucunoides*, *Centrosema acutifolium*, *Desmodium heterocarpum* ssp. *ovalifolium*, and *Pueraria phaseoloides*.

3.5.3. Legume species

Arachis pintoi (pinto peanut)

Pinto peanut – stoloniferous, tolerates shade, heavy graziing and low fertility soils, excellent feed quality

Arachis pintoi, locally known as **pinto peanut** or **kacang pinto** in Indonesia, is a stoloniferous, perennial legume developing a strong taproot on the older crowns and forming a dense mat of stolons. It is tolerant of heavy grazing and low fertility soils. It is highly productive for a legume, forms a good ground cover and combines well with competitive sward grasses such as buffalo grass and *Brachiaria* species.

Nutritive value and animal production

Having relatively low levels of condensed tannins and no other anti-nutritive factors, Pinto peanut has very high nutritive value for all classes of animals. It has 13-25% crude protein and 60-70% dry matter digestibility. Very high rates of liveweight production of cattle – approaching 1,000 kg/ha/yr – have been recorded in Central and South America.

Environmental requirements

Pinto peanut is among the most shade-tolerant of the tropical legumes tested, producing more growth in shade than in full sunlight. It is also tolerant of moderate periods of waterlogging and has low to moderate tolerance of salinity. Pinto peanut is grown throughout the wet tropics and subtropics, and the upland tropics at altitudes of up to 1,400 m asl and with rainfall ranging from 1,500 to 3,000mm annually. Whilst it can persist through short dry seasons, it becomes unproductive. Similarly, it tolerates flooding, but does not grow in waterlogged environments.

Soil requirements

Pinto peanut is generally found on red, sandy loam river-bottom soils of low to moderate fertility and high aluminium saturation, particularly in low areas that are wet or flooded during the wet season.

In cultivation, *A. pintoi* is not restricted by soil texture, growing successfully on soils with pH ranging from about 4.5 to 7.2. While it prefers moderate to high fertility, it can survive in infertile soils, having low requirement for copper, molybdenum and lime, a moderate requirement for phosphorus and zinc, and being tolerant of high levels of manganese and aluminium.

Establishment and growth

Pinto peanut can be established from cuttings or from seed, although plants established from seed develop an effective root system more rapidly. Moderate levels of dormancy in fresh seed can be reduced by

pre-drying at 40ºC for 10-14 days prior to planting. Once dried, seed should be stored in a cool dry environment; inadequately dried and inappropriately stored seed shows large reductions in viability within 10 months of harvest. Seed should be inoculated with CIAT 3101 (QA 1091) strain *Bradyrhizobium* – CIAT 3806 and 2138 also effective.

Seed should be sown at 10–30 kg/ha seed-in-pod depending on seed quality and price, and the desired early stand density. It should be sown 2–5 cm deep as surface sowings result in poor germination and high seed losses to birds and rodents. Care should be taken in selection of planting equipment as some machines can destroy the soft seed.

Pinto peanut does not generally require high levels of fertiliser. In very infertile soils in Colombia, an establishment application of P 20, Ca 100, K 20, Mg 14 and S 22 kg/ha and maintenance dressings every two years of half this amount have given consistently good results. It is unresponsive to Mo applied at establishment, due to high Mo reserves in the seed, but applications of Mo may be necessary in 2–3 year-old stands on very acid soils.

Centrosema pubescens (centro)

Centrosema pubescens, commonly known as centro, is a perennial, trailing-climbing legume that produces roots at the nodes of its trailing stems. It is used as a component of grazed tropical pastures in mixture with grasses such as guinea grass and signal grass. It can also be planted as a legume-only protein bank for cut-and-carry use.

Centrosema pubescens

Nutritive value and animal production

Centro is generally regarded as a moderately high-quality legume, with crude protein content of around 20% and in vitro DMD of 53%, although there are reports of CP content up to 26% and IVDMD of 71%. It is readily grazed by cattle and has no toxicities.

Centro / green panic pastures in humid Queensland, Australia supported liveweight gains of 550-650 kg/ha/year.

Environmental requirements

Subhumid to humid tropics with rainfall >2,000 mm/year. It is tolerant of moderate shading, but is most productive and persistent under full sunlight.

Soil requirements

Centro is adapted to acid, low fertility, well-drained soils.

Establishment and growth

Centro is normally sown by seed together with companion grasses (such as *Panicum maximum* or *Brachiaria decumbens*) into a well-prepared seed-bed at a rate of 1–2 kg/ha. It can also be sown by hand from vegetative sets. Centro does not generally require a specific Rhizobium inoculant.

Cultivar Belalto produced 12.8 t/ha/year DM in North Queensland, but only 6 t/ha/year DM under cutting in Quilichao, Colombia. It is considered to be a moderately productive twining legume.

Puero – twining, good early ground cover, persists under light grazing, good feed quality

Pueraria phaseoloides (puero)

Pueraria phaseoloides, commonly known as puero, is a vigorous, deep-rooted, perennial twining and climbing legume. Puero is primarily used as a component of grazed and ungrazed cover crop mixtures or as a component of grass-legume pastures in the humid-tropics. However, it can also be used as hay, silage, and cut-and-carry forage.

Nutritive value and animal production

Puero is a high-quality legume with crude protein levels of up to 24% high digestibility (IVDMD 60–70%). In the Colombian savannas, puero grown with *Brachiaria decumbens* grazed at 2 head/ha produced cattle LWGs of 160 kg/head/year, compared to 120 kg/head/year from grass alone. Daily animal gains ranged from 0.4 to 0.7 kg/head. In humid-tropical Vanuatu (south-western Pacific), the addition of puero to a para grass (*Brachiaria mutica*) pasture improved production by 22%, increasing annual LWGs from 511 to 621 kg/ha, and individual steer LWGs from 0.55 to 0.65 kg/head/day over a 3-year experimental period.

Puero is commonly of low to moderate palatability to grazing cattle during the wet season, but becomes substantially more palatable at flowering time probably related to the declining quality of the companion grass late in the season. It persists under moderate grazing pressure, but is sensitive to heavy grazing, particularly on poorly drained soils.

Environmental requirements

Puero prefers annual rainfall above 1,500 mm, but will grow in the sub-humid tropics with 1,000–1,500 mm/year, particularly where temporary waterlogging occurs. It is commonly grown in areas with more than 3,000 mm annual rainfall and is tolerant of temporary waterlogging and short periods of flooding.

Puero is adapted to low temperatures in the tropics (average minimum 15°C), but has poor frost tolerance. Good yields obtained at 1,500 m asl in the Colombian Andes.

It is moderately shade tolerant and is widely used as a cover crop in the establishment phase of oil palms and under older stands of coconuts.

Soil requirements

Puero is adapted to a wide range of soil types, but does not perform well on heavy clays or tolerate salinity. It grows well on acid soils (pH 3.5–5.5) with a high Al saturation, but prefers medium-high soil fertility, particularly P and Mg, and good drainage.

Establishment and growth

Puero seed must be mechanically scarified to break the hard seed coat for optimum germination. Cover crops are seeded at a rate of 4 kg/ha, at a depth of 1–2 cm into a well-prepared seedbed, or at 0.5–1.0 kg/ha in pasture mixtures. Growth in the first 6 months is slow compared with Calopogonium mucunoides, but subsequent growth is generally excellent. It does not requires a specific Rhizobium inoculant strain, but is responsive to P at establishment. As a green manure crop, the legume decomposes rapidly providing 50–100 kg/ha N. Puero can also be established using stolons.

Puero is generally more compatible with erect species and does not normally persist with *Brachiaria decumbens* or pangola grass (*Digitaria eriantha*). However, under moderate grazing pressure on well-drained

soils in high rainfall environments, persistent associations have been formed with stoloniferous grasses such as *B. mutica* in Vanuatu and *B. brizantha* in Brazil.

Annual DM yields of pure stands are high for a twining legume, ranging from 5 to 10 t/ha, with highest yields occurring in tropical environments with a very short, or no, dry season. Growing in combination with *B. brizantha*, puero fixed 194 kg/ha/year N and transferred 75 kg/ha N to the grass.

Stylosanthes guianensis (stylo)

Stylo, is a robust, semi-erect, short-lived perennial legume. It is used as a long and short-term pasture (grazed or cut-and-carry), for intercropping in rice, as a ground cover for erosion control in orchards, as a green manure, and as hay for leaf meal and pellets.

Nutritive value and animal production

Stylo is a legume of moderate quality, with crude protein content of 12–20% CP and dry matter digestibility of 52–60%. It is not readily eaten by cattle early in the growing season but becomes relatively more palatable as associated grasses mature later into the dry season.

Stylo pastures have supported cattle liveweight gains of 0.25–0.6 kg/hd/day and 300–500 kg/ha/yr.

Environmental requirements

Stylo occurs in areas with rainfall from 700 to 5,000 mm/year, but mostly with 1,000–2,500 mm/year. It is generally best in regions with more than 1,500 mm average annual rainfall.

Many cultivars of Stylosanthes guianensis are susceptible to the leaf fungus anthracnose but Ubon stylos from Thailand are more resistant.

Stylo is primarily adapted to the hot, humid tropics (average annual temperatures of 23-27°C) although some ecotypes grow satisfactorily in the humid subtropics as well. Stylo has little or no shade tolerance.

Stylo – free-draining, low fertility soils, not shade-tolerant, valuable dry season protein

Soil requirements

Stylo prefers well-drained, open-textured soils from sands to light clays of pH from 4.0 to 8.3, depending on ecotype. It is moderately tolerant of high Al and Mn but not of high salinity. Stylo has a lower requirement for Mo than many other tropical legumes.

Stylo responds well to improved soil fertility, particularly P, but can grow on infertile soil. In deficient soils, 10–20 kg/ha P is recommended as well as other nutrients as indicated by soil analysis.

Establishment and growth

Stylos can be planted from seed or vegetatively. Freshly harvested seed may have more than 70% hard seed and should be scarified by soaking in water at 55°C for 25 minutes, 70°C for 10 minutes or at 85°C for 2 minutes. Alternatively, seed can be mechanically scarified with an abrasive disc or rice polisher. Mechanical harvesting normally has a scarifying effect on the seed. Stylo is fairly promiscuous in its rhizobium requirements, often nodulating adequately on native Rhizobium. Seed is sown at 2–5 kg/ha.

Stylo in KAL

Where seed is scarce, about 80% strike has been achieved with cuttings 15–20 cm long, with lower leaves removed and with more than half the stem buried horizontally to 3–5 cm depth.

Stylo is generally planted as part of a mix of legumes together with companion grasses such as signal grass. It can be shaded out by taller grasses such as guinea grass, but can suppress weeds under correct management. Stylo will die out under excessive cutting or where weeds and other pasture species shade.

Stylo commonly produces yields of 5–10 t/ha DM depending on cultivar, growing conditions and management.

Stylosanthes hamata (Verano stylo)

The cultivar Amiga has better resistance to anthracnose than most guianensis lines but is more suited to drier and cooler environments.

Desmodium heterophyllum (hetero, sisik betook, heuheulangan, sukut jareman)

Hetero withstands heavy grazing and low fertility soils.

Desmodium heterophyllum is known as sisik betook, heuheulangan or sukut jareman in Indonesia, but as hetero elsewhere. It is a prostrate perennial, stoloniferous creeping legume. Hetero is a valuable component of grazed native pastures and of sown pastures dominated by aggressive creeping grasses. It is very tolerant of heavy grazing and also has very good shade tolerance. In combination, these characteristics allow it to persist under conditions of management that result in the loss of most other legumes.

Nutritive value and animal production

Hetero has moderate nutritive value, with crude protein content of 17–18% CP; base levels are increased by P (and S) application. It has moderate levels of tannins reported but palatability is generally good and no toxicities are reported.

In Fiji, LWGs of over 500 kg/ha/yr recorded on fertilised hetero in native pastures. In northern Australia, LWGs of over 700 kg/ha/yr have been obtained off signal grass (*Brachiaria decumbens*)/ hetero and pangola (*Digitaria eriantha*)/hetero pastures. In Samoa, LWGs of steers grazing a pasture of *Ischamemum indicum* were 220 kg/ha/yr; steers on I. indicum/hetero gained 370 kg/ha/yr.

Environmental requirements

Hetero requires at least 1,500 mm rainfall (up to 4,000 mm) of well-distributed annual rainfall. It is not drought-tolerant but will persist through moderate dry seasons of 5 months length.

Hetero is very shade tolerant and is often found under the canopy of shrubs in grasslands. It persists in well-grazed pastures under mature coconut plantations and yield is less affected under 50% light than many other tropical legumes.

Soil requirements

Hetero grows on a wide range of soils from sands to clays. It is very efficient at extracting phosphorus from infertile soils and will tolerate low pH and high Al, but has little salt tolerance. It tolerates waterlogged soils and short-term flooding.

Establishment and growth

Hetero is planted from cuttings of rooted stolons and aerial stems into moist soil where it will spread rapidly due to its free branching habit and free seeding. Grazing animals spread seed through dung and from yet-to-dehisce seedpod segments adhering to hair. Hetero will grow well in infertile soils but will respond vigorously to added P (and S).

It can be sown from seed but this is rarely available commercially and is expensive due to difficulty of harvest. If sown from seed, seeding rates can be as low as 0.25–0.5 kg/ha. Seed should be inoculated with an appropriate rhizobium (QA 982 or CB 2085 in Australia), although in most Indonesian locations it will associate with local rhizobium. Nitrogen fixation by hetero was 64 kg N and 110 kg/ha/year N with tall guinea (*Panicum maximum*) grass and *B. miliiformis* respectively.

Hetero is incompatible with tall tussock grasses but combines well with creeping or low-growing grasses such as DH and BD.

Yields of about 2 t/ha/yr have been obtained from grass-legume pastures and about 3–5 t/ha/yr under plantation crops when grown in pure stands.

3.5.4. Species for fodder banks

Pennisetum purpureum (Napier grass) and *Pennisetum hybrids* (King grass, Odot, others)

King, elephant and Napier grasses are robust perennial grasses forming large, bamboo-like clumps, with culms usually 2–3.5 m high (up to 7.5 m) and stems to 3 cm diameter near the base. They are mostly planted for cut-and-carry systems, and not for long-term grazed pastures. Young growth makes good hay, which can be fed as hay or pellets but coarse stems in older growth make it unsuitable for hay. Young growth also makes good silage, although it is inferior to maize and sorghum. Old growth becomes too coarse to be of value for anything other than soil conservation.

King grass – very productive with high fertility, best for cut-and-carry, harvest before thick stems develop

Nutritive value and animal production

The nutritive value of Pennisetum species varies greatly with age of regrowth and fertility, particularly nitrogen. For example, 6-week regrowth has 10% CP, whereas 10-week regrowth has 7.6% CP. CP and IVDMD levels of leaf range from 9.5 to 19.7%, and 68 to 74% respectively. They are extremely palatable to all classes of stock provided young leaf is fed. Nitrate poisoning in cattle can occur where high rates of fertiliser are applied and Pennisetum species form the entire diet.

As with dry matter, animal production from *P. purpureum* depends on growing conditions for the grass. Liveweight gains of 1 kg/hd/day during the growing season and 480 kg/ha/yr, and milk yields of >11 kg/day (4% fat) are achievable. Capable of carrying 2–7 beasts/ha in a grazed system.

Environmental requirements

Pennisetum species normally grow in areas with rainfall more than 1,000 mm, and on river banks in areas of lower rainfall. Although extremely drought tolerant by virtue of deep root system, they need good moisture for production but do not tolerate prolonged flooding or waterlogging.

They produce their best growth at between 25 and 40°C and grow from sea level to 2,000 m altitude.

Pennisetum species show moderate shade tolerance, about equivalent to that of *Brachiaria decumbens*.

Soil requirements

Pennisetum species grow on a wide range of soil types provided fertility is adequate, although prefers well-drained friable loams with a pH of 4.5–8.2.

Establishment and growth

King, elephant and Napier grasses can be established from seed, although they are almost invariably planted from setts or cuttings (pieces of cane) or splits (rooted pieces of clump). Setts are taken from the bases of moderately mature stems and should contain at least 3 nodes. These are pushed into the soil at 45º, basal end down, with 2 nodes buried. Cuttings can also be planted horizontally into a furrow, to a depth of 5–10 cm. Cuttings are normally planted in rows 0.5–2 m apart, and 0.3–1 m apart within rows. More open spacing is used in drier environments.

Pennisetum species should be planted into fertile soil. Once established, they require 150–300 kg/ha/yr N, together with other nutrients as indicated by soil tests. Yields decline rapidly if fertility is not maintained. Heavy application of feedlot manure is commonly used in Indonesia.

Yields depend on fertility, moisture, temperature and management. DM yields of 20–50 t/ha/yr are common, but can be up to 85 t/ha/yr if well fertilised. In contrast, yields of 2–10 t/ha/yr are more common if unfertilised. More frequent cuts (up to 45 days) give less dry matter, but better leaf (and animal) production than infrequent cuts.

Sesbania grandiflora (turi)

Turi – valuable fodder tree for cut-and-carry and for green manure

Sesbania grandiflora, locally known as turi, is an open branching tree up to 15 m tall and 30 cm in diameter. Roots are normally heavily nodulated with large nodules. It is valued as a fodder throughout Eastern Indonesia, particularly for dry season feeding of cattle and goats. In Lombok, turi is commonly grown on paddy bunds, and around gardens or cropping fields for its nitrogen contribution. Turi grows fast enough to be used as an annual green manure crop.

Turi is not generally directly grazed by livestock as this will kill the plant. In Eastern Indonesia's dry rangelands, it is often grown in grazed paddocks as mature trees out of browse height, or as cut-and-carry forage integrated into cropping systems.

Nutritive value and animal production

Turi is a high-quality legume containing 25–30% crude protein and up to 74% *in sacco* digestibility. It is highly palatable to ruminant livestock and is also generally well accepted by monogastrics. Turi contains low quantities of condensed tannins that may provide some bypass protein.

Supplementing guinea grass hay fed goats with turi increased intake by 25%. No long-term cattle production studies have been reported, but turi is a major component of ruminant diets in eastern Indonesia where it may comprise up to 70% of total forage allowance during the dry season.

Environmental requirements

Turi is best adapted to regions with annual rainfall of 2,000–4,000 mm, but has been grown successfully in semi-arid areas with 800 mm annual rainfall and up to 9 months dry season. It is tolerant of flooding over short periods. It is adapted to the lowland tropics with mean annual temperatures of 22–30°C.

Turi has poor shade tolerance.

Soil requirements

Turi is tolerant of a wide range of soils, including soils that are alkaline, poorly drained, saline, or of low fertility. It has some tolerance of acid-soils down to pH 4.5 and is well adapted to heavy clay soils.

Establishment and growth

Turi establishes rapidly from seed or by vegetative propagation from stem and branch cuttings. Turi establishes much faster than other common tree legumes such as *Leucaena*, *Gliricidia*, and *Calliandra*. In smallholder systems, turi is planted as individual trees or in rows, spaced 1–2 m apart along fence lines, field borders and the bunds of rice paddies. In fertile sites it will attain a height of 5–6 m in 9 months, although height increments are greatly reduced in the second year of growth. Turi is tolerant of low fertility soils so that no fertiliser is generally required.

An annual yield of 27 kg of green leaf/tree was achieved by harvesting side branches A green manure yield of 55 t/ha green material (approx. 11 t/ha DM) in 6.5 months was achieved in Java, Indonesia.

Leucaena leucocephala (lamtoro)

Leucaena leucocephala is known as lamtoro across Indonesia and PNG. It is highly valued as a ruminant forage by subsistence and commercial farmers throughout south-east Asia, northern Australia and parts of central Asia and Africa. It is planted in hedgerow systems with buffel grass (*Cenchrus ciliaris*) for cattle production in northern Australia, and as a hedgerow or fodder bank species in parts of south-east Asia and Africa.

Lamtoro – high quality hedgerow forage for browsing or cut-and-carry, needs fertile, free-draining soil, reasonable dry season, weed potential

Lamtoro is slow to establish, but is extremely tolerant of regular defoliation by cutting or grazing once established. Growing on a poorly drained clay soils in south-east Queensland, Australia had a half-life of 23 years under regular grazing, but much longer life span can be expected when grown on more suitable soil types.

Nutritive value and animal production

Lamtoro foliage is noted for its very high nutritive value for ruminant production. Typical values for the edible fraction are 55–70% digestibility, 20–28% crude protein (3–4.5% N). Leaves also contain 2–6% condensed tannins (CT) that protect dietary protein from degradation in the rumen. This by-pass protein is digested more efficiently in the lower gut.

Lamtoro is highly palatable to most grazing animals, but can require a period of adaptation for novice animals.

Lamtoro contains mimosine, a non-protein amino acid that has anti-nutritive effects on animals. Fortunately, a range of anaerobic rumen bacteria, including *Synergistes jonesii*, is able to completely detoxify

mimosine and its breakdown products. These rumen bacteria occur in all countries where lamtoro is commonly used, however, caution should be exercised when introducing novice animals to lamtoro.

Lamtoro supports excellent animal production. Growth rates of 1.26 kg/head/day for cattle grazing leucaena-buffel grass (*Cenchrus ciliaris*) pastures over a 6-month period were reported in Queensland, Australia, although growth rates are more commonly 250–300 kg/head/year (0.7–0.85 kg/head/day). Under irrigation in north-western Australia, annual liveweight gains of up to 1,700 kg/ha/year have been recorded for cattle grazing at 6 head/ha.

Environmental requirements

Lamtoro prefers subhumid and humid climates of 650–1,500 mm and up to 3,000 mm annual rainfall and tolerates up to 7 months dry season. It does not tolerate waterlogged soils or periods of flooding over 3 weeks). Lamtoro requires temperatures of 25–30ºC for optimum growth. It grows readily in 50% sunlight environments and is productive under mature coconut palms in Vanuatu and Indonesia.

Heavy infestations of plant-sucking insects (Psyllids) can greatly reduce growth and yields of leucaena. In northern Australia, infestations were heaviest in higher rainfall regions along the coast. As a result, major planting of leucaena have been concentrated in drier areas further inland. Under these drier conditions, rows of leucaena have been planted up to 9 metres apart and the interspace kept plant free to accumulate moisture in the soil. Row spacing in Indonesia will greatly depend on the severity of infestations of psyllids. Very heavy infestation appear to be declining over the years.

Soil requirements

In its native range, lamtoro grows on shallow limestone soils, coastal sands and seasonally dry, self-mulching clay soils of pH 7.0–8.5. In exotic locations, it requires well-drained soils with pH above 5.5, or above 5.0 where aluminium saturation is very low. Lamtoro is intolerant of soils with low pH, low P, low Ca, high aluminium saturation, high salinity and waterlogging, but is tolerant of moderate salinity and alkalinity.

Establishment and growth

Lamtoro is relatively slow to establish and is easily outcompeted by weeds in early growth. For best results, maintain a weed-free area of at least 2 m either side of the establishing plants. Seed must be scarified to break the impermeable coat. Mechanical scarification, using coarse sandpaper (for small seed lots) or abrasive-lined rotating drum scarifiers, is used. Specific rhizobium is also required (e.g. CB3060, TAL1145, LDK4) in areas with no existing stands of lamtoro.

Complete cultivation is recommended in extensive plantings. In drier areas of Australia, lamtoro is planted into rows 4–9 m apart at seeding rates of 2–3 kg/ha. Post-plant herbicides such as bentazone and imazethapyr can be used to control weed seedlings in the rows. Rolling cultivators can be used to control very young weed seedlings and break soils crusts after emergence of leucaena seedlings.

Small areas can be planted using either seed or seedlings. Seedlings are normally raised in poly bags for plug planting at 3-4 months old, but can also be raised in beds and removed for planting as bare-rooted seedlings if 'topped and tailed'.

Lamtoro is normally not fertilised under rain-grown conditions. Starter N and P may be used when establishing lamtoro into depleted soils. On acid-infertile soils, it is essential to add lime, P and K at planting and after each cut.

Yields of forage vary with soil fertility, rainfall, altitude, density and cutting frequency from 1–15 t/ha/year. Leaf yield is maximised by cutting at 6–12 week intervals during the growing season. Yields in extensive hedgerow plantings in the dry tropics and subtropics generally range from 2–6 t/ha/year. Very high yields (>15 t/ha/year) have been achieved in Southeast Asia and Hawaii with plants 0.5–1.0 m apart in rows 1–3 m apart.

Lamtoro is compatible with a range of grass species but is difficult to establish into existing grass pastures without complete grass control or clean cultivation. In sub-humid, tropical Australia, lamtoro is grown with buffel grass, green panic (*Panicum maximum* var. *trichoglume*), Rhodes grass (*Chloris gayana*) or bambatsi panic (*Panicum coloratum*). In Papua New Guinea, Vanuatu and humid-tropical Australia, it has been grown with humidicola (*Brachiaria humidicola*), signal (*B. decumbens*) and buffalo grass (*Stenotaphrum secundatu*m).

Indigofera zollingeriana (tarum)

Indigofera zollingeriana, (previously *I. teysmannii*) and locally known as taum, is a shrub or small tree that can grow to 12 metres tall, but is more commonly 2–3 m. It has traditionally been used as a green manure crop and to provide shade in plantations, but more recently has been used as a feed for ruminants in Indonesia. From feeding trials in Bogor, it is reported to be of high nutritive quality for ruminant production.

Indigofera can be harvested at the age of eight months with an average production of 2,600 kg of fresh biomass/tree, with a total production of fresh biomass of about 50 tonnes/ha. *I. zollingeriana* is often used as green manure, as a cover crop in plantation areas, for fabric dyeing and as therapeutic herbs.

Indigofera – shrub legume for cut-and-carry or green manure

Nutritive value and animal production

Use of *Indigofera zollingeriana* in dairy goat rations was reported to improve milk production and reduce feed costs in Indonesia. *Indigofera zollingeriana* has crude protein content of 27.6%; neutral detergent fiber (NDF) 43.6%; acid detergent fiber (ADF) 35.2%; calcium (Ca) 1.16%; phosphorous (P) 0.26%; in vitro-dry matter digestibility (IVDMD) 67.5%; organic matter digestibility (IVOMD) 60.3%. Unlike many other *Indigofera*, *Indigofera zollingeriana* contains low concentrations of anti-nutritional elements, specifically 0.08% tannins and 0.41% saponin, but these do not impact its value as a feed for ruminants..

Cattle may not find tarum palatable at first but intake gradually increases over the first two or three days. Cattle fed *I. zollingeriana* in Indonesia readily consume all that is available, suggesting at least moderate palatability.

Environmental requirements

Indigofera zollingeriana grows well at altitudes of up to 2,200 m above sea level, with rainfall between 1,200 and 3,000 mm/year

Soil requirements

Indigofera zollingeriana is tolerant acid soils, including locations with periodic waterlogging.

Establishment and growth

Seed is hard seedcoat and may benefit from scarification before sowing in order to speed up and improve germination.

Indigofera can be harvested or grazed at about 6 months after planting. It is highly tolerant of regular cutting and rotational grazing. There are no reports of it being continuously grazed and it may be less persistent under such management.

Indigofera was reported to produce approximately 52 t/ha of fresh biomass. Separate research conducted in Bogor showed that indigofera was able to produce 30–50 t of fresh biomass/ha/year planted in a row with planting density of 6600 tree/ha, and with a cutting interval of 60 days.

In an acidic soil, *Indigofera* produced 2.6 t DM/ha/harvest, whilst in the podzolic soils with neutral pH it produced 4.1 t DM/ha/harvest at 90 days after planting.

In Vietnam, *Indigofera* produced the highest biomass out of six tree legumes – *Gliricidia sepium, Acacia auriculformis, Desmodium* sp, *Flemengia congesta* and *Leucaena leucocephala*. It produced 8.4 t DM/ha/year compared to 3.6 t DM/ha/year of *Leucaena*.

Animal production

There is relatively little information examining ruminant production from indigofera, however anecdotal information from IACCB projects indicates that indigofera is highly palatable to cattle and results in good liveweights gains when fed in sufficient quantities.

In a feeding trial conducted in South Sulawesi, Ongole beef cattle fed with 40% indigofera and 60% elephant grass gained 0.45 head/day.

Dairy PE and Saanen goats fed with fresh I. zollingeriana forage to a level of 100% ration showed an increase in milk production of 14–28% above the standard ration in Indonesia. In a separate study, adding up to 60% *I. zollingeriana* in the ration, either as wilted fresh material or pelleted leaf material, significantly increased both liveweight gain and milk production of dairy goats and kids compared with animals fed native grass or Napier grass alone.

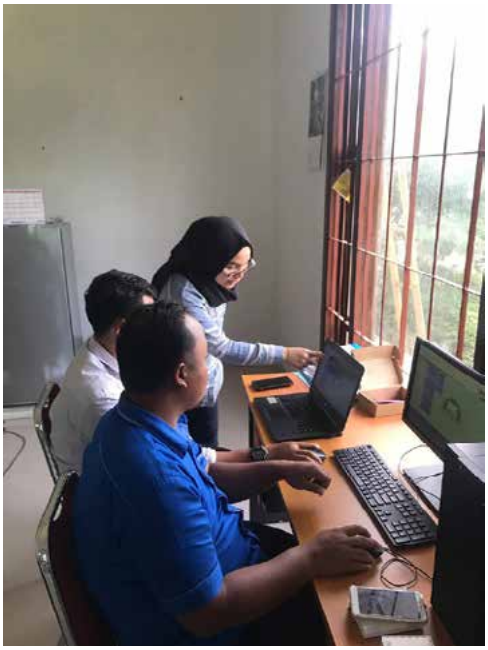
4. Monitoring and evaluation in a cattle breeding enterprise

Introduction

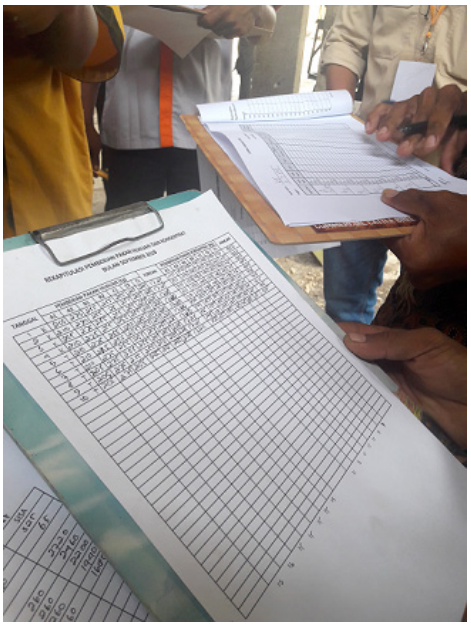
Monitoring and evaluation (M&E) is the process of keeping records of key indicators of business health and analyzing these records to examine current and plan future processes and strategies. If undertaken effectively, the lessons learned through the M&E process will lead to improvements in the productivity and profitability of commercial cattle breeding businesses in Indonesia.

Module 4 provides a description of the M&E cycle, how M&E fits into day-to-day operations and how it can contribute to continuous improvement. Key performance indicators (KPIs) are provided (Section 4.2 Cattle KPIs)), along with methods of measurement and benchmarks developed within Indonesia. Indicators for oil palm plantations are provided in Section 4.3. Finally, labour and operational costs are covered in Section 4.4 on enterprise costs.

These KPIs are entered into the tools (downloadable off the internet) and produce graphics of KPIs to inform management of progress in achieving production and profitability goals. More detailed Information on CALPROS and CALPROF is provided at the end of Section 4.4.



IACCBP software training for company administration staff



4.1. M&E in the business cycle

Each business is comprised of a set of interrelated activities that are designed to achieve a goal, using existing resources and within a certain time period. In general, the business cycle consists of four basic stages – Planning, Implementation, Monitoring and Evaluation, and Action. Monitoring is a process of gathering data – key measurable indicators.

Evaluation is the process of analyzing data to produce information that is used to make informed management decisions. The process should be planned from the beginning of the investment so that it can be used as a guide to monitor the progress during project implementation and adapt implementation accordingly.

M&E

M&E is often referred to as 'record-keeping' and 'audit' in the cattle sector.

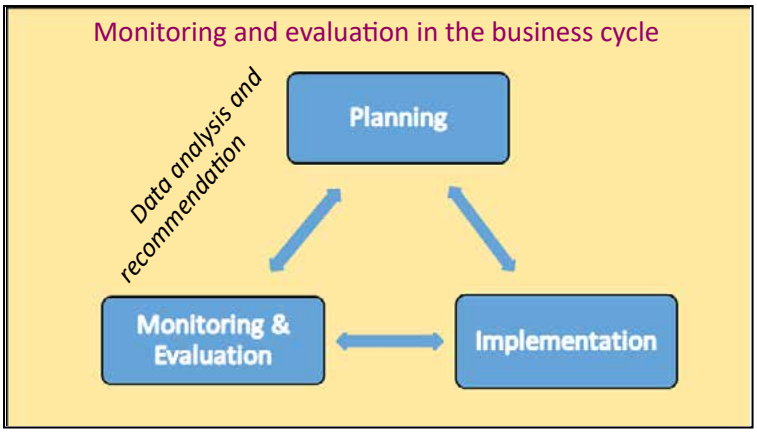
Whatever terminology is used, we are referring to the process of collecting and analysing data on key performance indicators and using this information for a process of continual improvement.

An effective M&E program will underpin the process of improvement. A formal approach to M&E will greatly improve the ability of the businesses to learn from errors and experience.

M&E allows us to examine the outcomes of implementation and take action to improve for the future. Improvements can be made from an 'evidence-base', rather than from 'gut' feelings. It is particularly important when we need to change an operational aspect.

A formal approach to M&E will greatly improve the ability of the businesses to learn from errors and experience. The importance of M&E is most acute during the start-up phase, when errors and learning are occurring rapidly.

Mature businesses will have fewer shocks and reduced scales of learning and improvement simply because of time and experience. However, small gains can still be made and are important in achieving profitability over the long-term.



4.2. Key performance indicators for commercial cattle breeding

A range of KPIs are used across most cattle breeding enterprises. These KPIs provide essential information on the productivity and efficiency of the operation and underpin the M&E system. Business management software and financial viability assessment models will require most of these KPIs to generate their reports. Herd management software typically generates reports on the most important of these KPIs. The KPIs used in Indonesia are discussed below. Outputs from the IACCB spreadsheet CALPROS and the software, CALPROF, are provided as an example of the program's utility.

4.2.1. Body condition score

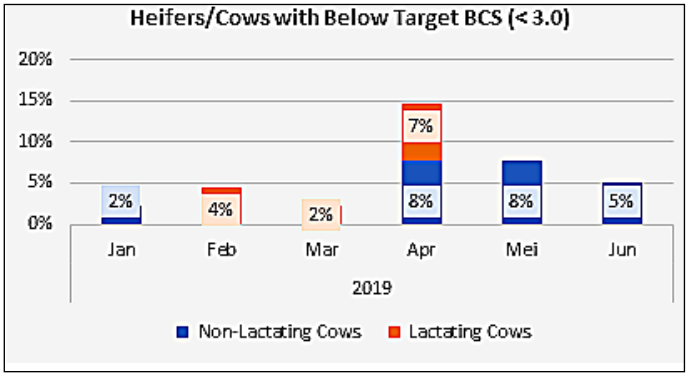
The health of the breeding herd is the primary driver of a cattle breeding enterprise. A rapid method to assess herd health is Body Condition Score, known as BCS. BCS is generally comprised of a scale from score 1 to score 5, with score 1 being weak, skinny cows in poor condition and score 5 being over-fat cows (see BCS poster on the following page).

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
BCS (body condition score)	An indicator of cattle condition – essential to achieve high calving rates	Using an industry standard scale 1 to 5	Cows ≥3.0 Bulls >3.5	BCS is a visual assessment of muscle / fat cover of cattle. Cows with low BCS will be unproductive. Weaners and growers are evaluated on ADG, not BCS

Cows with low BCS will have long calving intervals, be more susceptible to calving problems, produce lighter calves and calves that grow more slowly than cows that are in better condition. The aim is to maintain cows with a BCS of ≥3.0 at all times. Cows that are very fat, BCS >4.5, can have problems with anestrous and generally indicate that excessive money is being spent on feed.

When BCS is tracked over time it becomes easier to predict when additional supplementary feeds will be required. Figure 1 below shows how the BCS of the herd declined in April, with 15% having below target BCS. Additional supplements were provided in early May and significant recovery had occurred by the end of the month.

Figure 1. Proportion of the breeding herd with BCS <3 (2019)



There is a common adage that "Happy cows are profitable cows". Whilst this may be true, it will depend on the ability of the enterprise to identify low-cost feed options of the necessary quality for each class of stock. What is more commonly correct is that unhappy cows will be unprofitable!

Weaners, growers and feeder cattle should always have high BCS, as the goal with these animals is to achieve the highest liveweight gains possible. It is usual to track condition of weaners and growers by liveweight gain rather than by estimating BCS.

Estimating BCS. Photo standards for BCS are readily available from the internet, including this one developed for Indonesia. Most stockmen will quickly develop an ability to score BCS. This can be done for each cow in the herd, or there can be a focus on the low BCS cows in the herd. As soon as the stockmen observe more than 5% of the herd with BCS <3.0 it should trigger the provision of additional supplementary feeds.

IACCB

Indonesia Australia Commercial Cattle Breeding Program

SKOR KONDISI TUBUH SAPI
(*Body Condition Score*/BCS)

BCS 1

1. Induk akan mudah stres – bisa mengakibatkan keguguran dan induk akan meninggalkan pedet
2. Pedet tidak ada susu dari induk – pedet kemungkinan besar akan mati atau tidak akan tumbuh
3. Induk tidak bisa bunting lagi – peternak pasti rugi

BCS 2

1. Induk bisa stres – ada kemungkinan keguguran dan kemungkinan induk meninggalkan pedet
2. Pedet sedikit susu dari induk – pedet kemungkinan mati atau pertumbuhan lambat
3. Induk kemungkinan tidak bunting lagi – peternak bisa rugi

BCS 3

1. Induk tidak mudah stres – pedet akan lahir normal dan induk tidak akan meninggalkan pedet
2. Pedet mendapat cukup susu dari induk – pedet hidup dan pertumbuhannya normal
3. Induk bisa bunting lagi – peternak untung

BCS 4

1. Induk tidak mudah stres – pedet akan lahir normal dan induk tidak akan meninggalkan pedet
2. Pedet mendapat cukup susu dari induk – pedet hidup dan pertumbuhannya normal
3. Induk bisa bunting lagi – peternak untung
4. Pastikan berat tidak bertambah, perhatikan pakan, induk harus banyak bergerak
5. Induk besar kemungkinan terkena *prolapsus*

BCS 5

1. Induk terlalu gemuk, sehingga sulit bunting
2. Kemungkinan tidak terjadi birahi
3. kemungkinan terjadi distokia
4. Kemungkinan infeksi/metritis
5. Kemungkinan terkena *prolapsus*

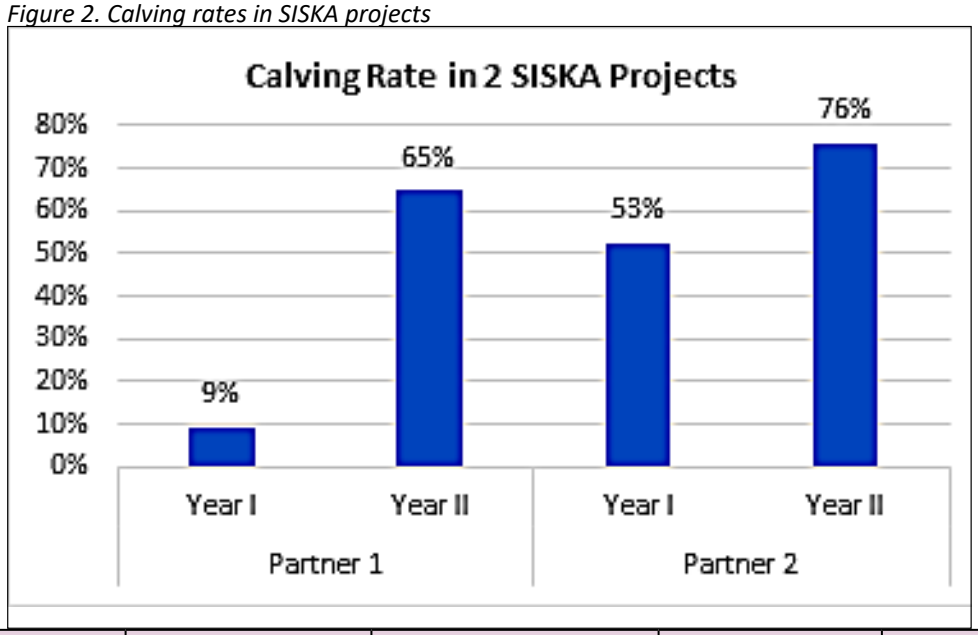
The IACCB Program is managed by Coffey, a Tetra Tech company in association with Swisscontact, on behalf of the Australian Government

4.2.2. Conception and calving rates

Cows in good condition should achieve a high conception rate if they have access to working bulls or effective artificial insemination programs. Cows can be pregnancy tested every 3 to 4 months to determine their pregnancy – known as pregnancy diagnosis (PD). An experienced stockman, para-vet or veterinarian will be able to do PD with a high level of accuracy using the rectal palpation method. Ultra-sound is also becoming more popular, but the PD instrument required is expensive.

Pregnant cows can suffer from abortions or still-births for a range of reasons. See Section 2.8 on animal health for more information. The combination of conception rate and losses from abortion and still-birth results in the calving rate – the number of live calves born per number of breeders. The target calving rate for a breedlot should be at least 85%, because there is significant ability to manage conception and calving. Lower target will be reasonable for more extensive systems. Figure 2 shows calving rates during the start-up phase of two SISKA projects. Project 2 experienced significant difficulties in Year 1 due to a lack of working bulls but achieved a reasonable result in Year 2. Better management and supervision of cows during the calving period should result in fewer losses due to abortion and still-birth.

Figure 2. Calving rates in SISKA projects



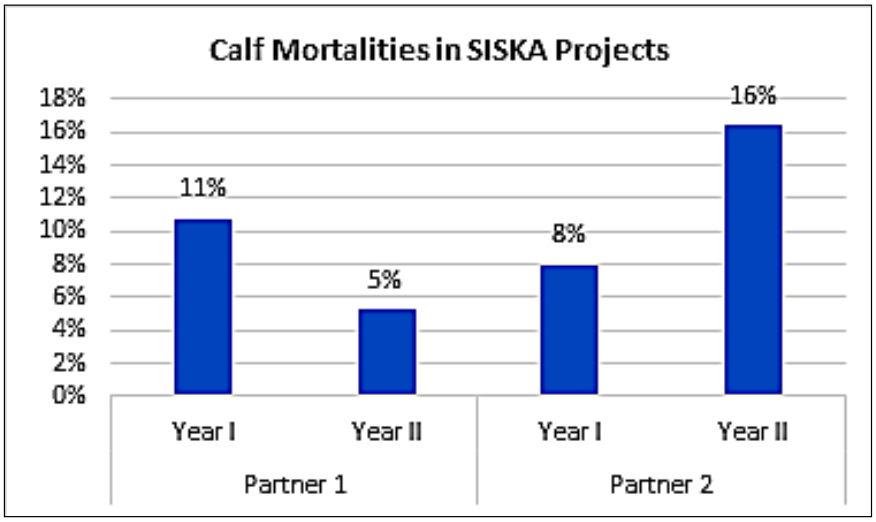
Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
Conception rate	Percentage of cows getting pregnant in a 12-month period	Number of pregnant cows divided by number of breeding females in the opening stock position	KPI >90% for cut-and-carry KPI >80% for SISKA	A high conception rate requires cows to be in good condition (BCS≥3.0) and the availability of good quality working bulls or effective AI program
Still-birth, abortion rate	Percentage of pregnant cows that do not deliver the calf due to still birth or abortion in a 12-month period	No. of pregnant breeding females that do not deliver the calf divided by number of breeding females in the opening stock position	KPI <5% for cut-and-carry KPI 5-10% for SISKA	Generally linked to condition of cows, but also impacted by extreme humidity or heavy rain
Calving rate	Percentage of breeders delivering a live calf in a 12-month period	No. of calves born divided by number of breeding females in the opening stock position	KPI >85% for cut-and-carry KPI >70% for SISKA	The result of conception rate, less problems with abortion and birthing

4.2.3. Mortality rates

Deaths of stock are obviously unwanted, both from animal welfare and economic perspectives. By the time a calf is born it has cost between Rp5 and Rp8 million. It is important not to lose it due to neglect or misfortune after all of the effort that has contributed to its birth. By tracking calf mortality, management will be able to identify causal factors and address these. Calf mortality usually considers all calves up to the time of weaning. However, if calves are weaned at 3 to 5 months, it would be sensible to include the period immediately following weaning as this is another time when losses can occur. Calves that are weaned at more than 8 months old are generally stronger and less susceptible to weaning shock, but their mothers suffer from the ongoing stress of lactation and will have longer calving interval.

Calf mortality in a breedlot should be <3%, whereas <5% is a more realistic target in extensive systems. Figure 3 shows calving percentages for two SISKA projects over the first 2-years of start-up. High calf mortalities occurred in Project 2 in Year 2 due to peak calving occurring during the peak of the wet season. The high mortality rate was due to pneumonia, infections from screw fly strike and dog attack. Controlled joining will go a long way to addressing the first two causes of calf mortality. See Section 2.8 on animal health for more detail.

Figure 3. Calf mortalities in SISKA project



Deaths of mature cattle are less common but can occur due to a range of issues. Post-mortems should be performed to determine the cause of death as this will lead to solutions to the problem Common causes include:

- Birthing difficulties, particularly in low BCS cows
- Diseases such as bovine ephemeral fever
- Health issues such as pneumonia
- Parasites such as screw fly
- Ingestion of plastic bags
- Consumption of poisonous weeds.

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
Calf-mortality rate	Percentage of calves that have died in a 12-month period	No. of died calves divided by number of calves born	KPI <3% for cut-and-carry KPI 5-10% for SISKA	Related to the condition of calves and cows; the cleanliness of pens and water; seasonal factors such as intense rainfall; incidence of pests and diseases, dog attacks
Mature cattle mortality rate	Percentage of cattle population that has died in a 12-month period	No. of died cattle divided by number of cattle in the opening stock position	KPI <3%	Generally low for companies with good management - BCS ≥3.0, capable stockmen, etc.

4.2.4. Weaning rates

Being the outcome of conception less losses from abortions, still-births, and calf-mortality, the weaning rate is a key driver of early success. Stockmen have a key role to play in rapidly addressing animal health issues in calves to achieve the highest possible weaning rate from the calf drop.

When to wean?

IACCB originally recommended weaning at 80kg liveweight at 3-4 months. This allows time for the cow to recover and potentially supports a 12-month calving interval.

Whilst achievable in a well-managed breedlot, weaning at 100kg at 5-6 months old is more realistic for most other operations. Early weaning requires provision of high-quality creep feed prior to and after weaning. Without this, weaners take a long time to achieve target growth rates and may never fully recover.

Weaning rates in extensive systems can be lower than 50% - only half the breeders producing a weaned calf each year. It is unlikely that an operation with a weaning rate below 60% will be profitable. It can take several years to lift weaning rates to the benchmarks. For SISKA systems, a weaning rate of 75% would be a good result, whereas higher weaning rates are expected in a breedlot.

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
Weaning rate	Percentage of calves weaned per total number of breeders in a 12-month period	No. of weaned calves divided by number of breeding females in the opening stock position	KPI >80% for cut-and-carry KPI >65% for SISKA	The result of calving rate, less calf mortality. Weaning at 100kgs/5-6 months old is recommended to reduce the calving interval. Light weaning may be possible in cut-and-carry (>80kgs at 3 mths)

4.2.5. Calving interval

Ideally, breeding operations want their cows to produce a calf every year of their productive life. This is possible in environments where cows and calves are well fed and calves and weaners are provided with high-quality pre- and post-weaning rations (see Section 2.9 Rations). It is much easier – although not easy - to achieve a 12-month calving interval in a commercial breedlot than in SISKA and open grazing systems. Realistically, achieving a 13-month calving interval in a breedlot is a good result, whereas the target for SISKA and open-grazing systems is more likely to be 15 months. A herd calving interval of 15 months over a 5-year period would result in an acceptable 80% calving rate.

A constraint of calving interval as a metric is that it only provides information on cows that have had more than one calf and does not include cows that have not calved in the target year. It is more useful when considered in conjunction with calving rate. It does provide a measure of the fertility of individual cows – very useful when improving the overall fertility of the herd.

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
Calving interval	The average number of months between calves for each cow	The average number of months between calves for each cow in a stated period. Can only be determined for cows that have produced more than one calf	13 months for cut-and-carry; 15 months for SISKA & open grazing	Much easier to achieve in breedlot than in SISKA and open grazing systems. Does not factor in cows that have not calved in the target year

4.2.6. Liveweight gains and cost of gain

A major objective for any cattle enterprise is to produce the desired liveweight gain for each class of cattle at the lowest cost possible using a sustainable production system. Tracking the liveweight gain of growing cattle enables the enterprise to benchmark against similar producers.

From research experience, the cost of producing a calf in Indonesia will always be higher than the potential sale price of the calf. Profitability is achieved by growing the calf to a feeder or market-ready weight as efficiently as possible. This is where the cost-of-gain is considered.

Low-quality feeds may be cheap to buy but may not provide the lowest cost of gain. Mixing feeds and by-products to form a ration that achieves the target liveweight gain at the lowest cost is essential in achieving profitability. *Section 2.9* provides a range of rations and their costs. The feed options for each enterprise need to be developed with consideration of the available pastures, forages, by-products and concentrate feeds that are locally available and their costs.

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
ADG- weaner / feeder growth rates	Average daily gain (ADG) of weaners and feeders	ADG of weaners 100kg – 320kg expressed as kg/ head/day ADG of feeders >320kg liveweight	ADG 0.5kg/head/ day for weaners ADG 0.6kg/day for feeders	Growth rates heavily depend on quality and quantity of feed rations and can be much higher than the suggested KPIs
Cost-of-gain	Variable costs to produce 1kg liveweight	Feed and labour costs required for a grower to gain 1kg	Rp20,000 to Rp35,000	The cost-of-gain largely determines the profitability of the enterprise.

4.2.7. Culling rate

Unproductive cows and bulls should be culled from the herd according to standard operating procedures. Animals to be culled include:

- cows that are aggressive
- cows that fail to get into calf within one year of reproductive maturity
- aggressive bulls
- inactive bulls
- heifers and grower bulls with poor conformation or temperament

The exact timing of culling for heifers will depend on the maturity of the operation and the quality of the bulls or AI program.

Individual companies may have preferences for particular breeds or genetic traits.

The genetic quality of the herd will improve over time with the use of good quality bulls or artificial insemination and with the gradual culling of lesser quality cows and heifers.

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
Culling rate	No. of cattle culled due to sickness, bad temperament or poor growth	No. of culled cattle divided by number of cattle in the opening stock position	Determined based on company objectives and initial stock quality	Unproductive cows and bulls should be culled from the herd, they cosst money. Improve herd genetics with additional culling to meet company objectives.

4.3. Key oil palm performance indicators

4.3.1. Weeding costs

Normal plantation practices include herbicide spraying of weeds once or twice each year. When grazing cattle are introduced, the requirement for weed control decreases. The savings made on weed control include both herbicide and casual labour costs. These saving are generally split between the cattle unit and the plantation unit.

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
Reduction in weeding costs due to grazing cattle	Savings in weed control costs as a result of grazing cattle controlling excess vegetation growth	Average weeding costs per ha in ungrazed blocks, less weeding costs in grazed blocks	Target savings of Rp25,000 to Rp40,000 /ha/yr	Essential to alter normal practice to target only unpalatable weeds. Costs may increase slightly in year 1 if plantation is weed-infested.

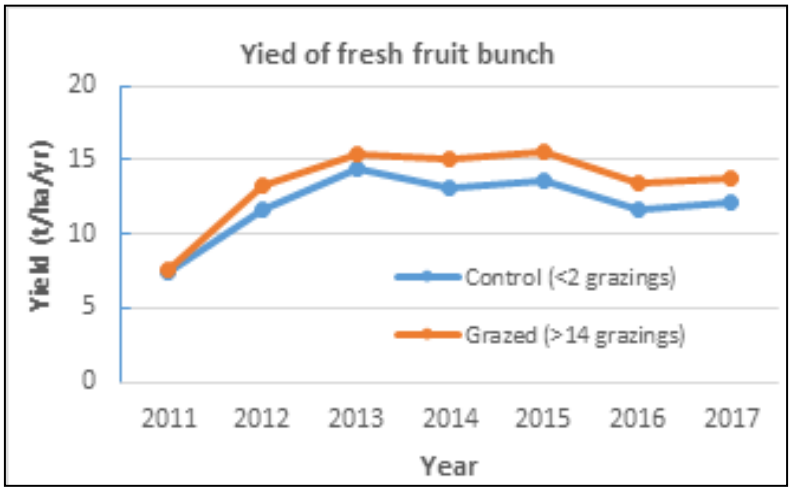
4.3.2. FFB yields

Preliminary research from IACCB, using plantation production data, has shown that the grazing of cattle under palms can stimulate yield of oil palm, probably through improved nutrient cycling.

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
% change in FFB yield	Change in annual FFB yield due to cattle grazing	% change in annual FFB yield of grazed vs ungrazed blocks of similar age and condition	10% increase has been recorded on average	Yield increase will take up to 2 years to occur due to delay between fruit set and harvest

At one plantation the increase of fresh fruit bunches (FFBs) was approximately 10 to 12% (see figure 1 below), but this effect needs to be confirmed through ongoing research. Plantations can do this themselves by tracking the yield of grazed and ungrazed oil palm blocks that are otherwise similar in terms of age, yield history prior to grazing, soil type and other factors. A yield increase of 10 to 12% is worth over US$200/ha annually and would normally be apportioned equally to the cattle and plantation business units.

Figure 1. Effect of frequency of grazing on the yield of fresh fruit bunch



4.4. Enterprise costs

4.4.1. Direct costs – ration costs

Cattle feeds in Indonesia are generally a combination of by-products, concentrates, minerals, forages and, in some cases, pastures. Each location should make use of the lowest-cost by-products and other feed sources available to achieve the required protein content and metabolizable energy target. See Section 2.9 for sources of cattle feeds.

Pastures are normally the lowest cost feeds in extensive systems but will need to be supplemented with concentrate feeds to sustain condition of grazing cows. For example, under-story native grasses in palm plantations can provide a low-cost maintenance feed for dry cows but will not sustain pregnant or lactating cows. Additional supplements must be fed to increase intake of protein, energy and minerals. Fodder banks and specialist pastures can also be developed to provide additional high-quality feeds. See Section 2.9 for details of rations.

Targets for feed costs and associated labour costs need to be established for breeding and fattening components of the cattle enterprises. The IACCB program has established benchmarks based on experience to date.

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
Ration costs for weaners, feeders and dry, pregnant and lactating cows	Amount spent on feed costs on a daily or weekly basis	Total cost of supplementary feeds per day or week divided by total number of stock fed	Cows under SISKA <Rp3,000 Breedlot cows <Rp12,000 Feedlot weaners <Rp10,000	Ration costs should achieve the target liveweight gain at the lowest possible price
Annual pasture costs	Annual cost/ha of maintaining an improved pasture	Total annual cost/ha of fertilisers and weed control to maintain improved pastures	No benchmarks exist at present	Will generally involve 2 – 5 days of labour for weeding plus fertilizer as required – generally cattle manure

4.4.2. Other direct costs

Other direct costs include any expenses that can be contributed directly to cattle production. This include fertiliser costs as part of pasture maintenance and animal health costs.

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
Fertiliser costs	Annual cost of fertiliser including application costs	Annual cost of fertiliser including application costs	Vary, depend on site location	For SISKA, fertiliser for palm is paid by the plantation. Often just the cost of spreading cattle manure
Annual animal health costs per head	Annual cost of all animal health inputs per head	Calculate total cost of all animal health inputs – vet, medicines, consumable, divided by number of cattle	Vary, depend on site location	Should include parasite treatment, vaccines, PD, general control of disorders

4.4.3. Operational costs - labour costs

There is a general lack of labour skilled in cattle breeding in Indonesia. This can be a particular constraint in remote locations, such as the SISKA plantations in Kalimantan and Sumatra. Good stockmen are attentive to issues arising in the herd, addressing them before they become problematic. This is particularly important around calving and weaning. Human resources are also required for administration and record-keeping and for security. Casual labour is required for weed control, feed mixing and feeding, cleaning yards, etc.

4.4. Enterprise costs

Benchmarks from active cattle breeding enterprises in Indonesia suggest that a ratio of one stockman to 100 cows should be achievable for efficient operations with herds of greater than 300 head. Higher labour inputs will be needed for intensive production systems.

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
Cost of management staff	Annual cost of all management staff contributing to cattle component	Annual cost of all management staff contributing on cattle component	Generally one mid-level manager running the cattle breeding unit	Track costs from year to year to determine management costs
Cost of operational staff	Annual cost of all operational staff working on cattle component	Annual cost of all operational staff working on cattle component	Depends on minimum local wage regulation and operational factors	Track costs from year to year to determine efficiency of labour.
Cost of supporting staff: security, administration, kitchen, other	Annual cost of all supporting staff contributing to cattle component	Annual cost of all supporting staff contributing on cattle component	Depends on minimum local wage regulation and operational factors	Track costs from year to year to determine efficiency of labour
Cost of irregular labour – weeding & pasture development	Annual cost of all casual staff working on cattle component	Annual cost of all casual staff working on cattle component	Depends on minimum local wage regulation and operational factors	Track costs from year to year to determine efficiency of labour
Staff / cattle ratio	Total number of cattle divided by number of full-time staff	Total number of cattle divided by number of full-time staff in a year	For SISKA: one full-time staff per 50 - 100 head For breedlot: one full-time staff per 20 - 30 head	Changes dramatically with herd size and type and efficiency of operation

4.4.4. Other operational costs

It is important to capture all costs associated with cattle production so that the true viability and profitability of the enterprise can be determined. A range of operational costs are listed below. Each enterprise may identify additional operational costs and these should be added to the list below. It is common and desirable for integrated businesses to share costs and returns where both benefit from the inputs. The apportioning of costs and benefits will need to be determined by each enterprise, preferably during the planning stage.

Performance indicator	Definition	How to calculate	Benchmark KPI	Comment
Machinery and vehicle operational costs	Annual cost of fuel, oil, repairs and maintenance for tractors, three-wheelers, motorcycle and other machinery. This includes rent cost of tractors.	Annual cost of fuel, oil, repairs and maintenance for tractors, other vehicles and other machinery	Vary, depend on site location	Generally purchase cost of tractors etc is bourn by the plantation. Operational costs are paid by the cattle unit
Infrastructure maintenance costs	Annual cost of maintenance the infrastructure	Annual cost of maintenance the infrastructure	Vary, depend on site location	This include cattle yard, cattle pen, cattle handling equipment
Cattle transport costs	Cost per head of transport to market or other	Cost per head of transport to market or other	Vary greatly with location and markets	Typically transport to market but also transport within the business unit
Cattle sale costs	All costs associated with sale of cattle	All costs associated with sale of cattle	Vary greatly with location and markets	Agents fees etc.

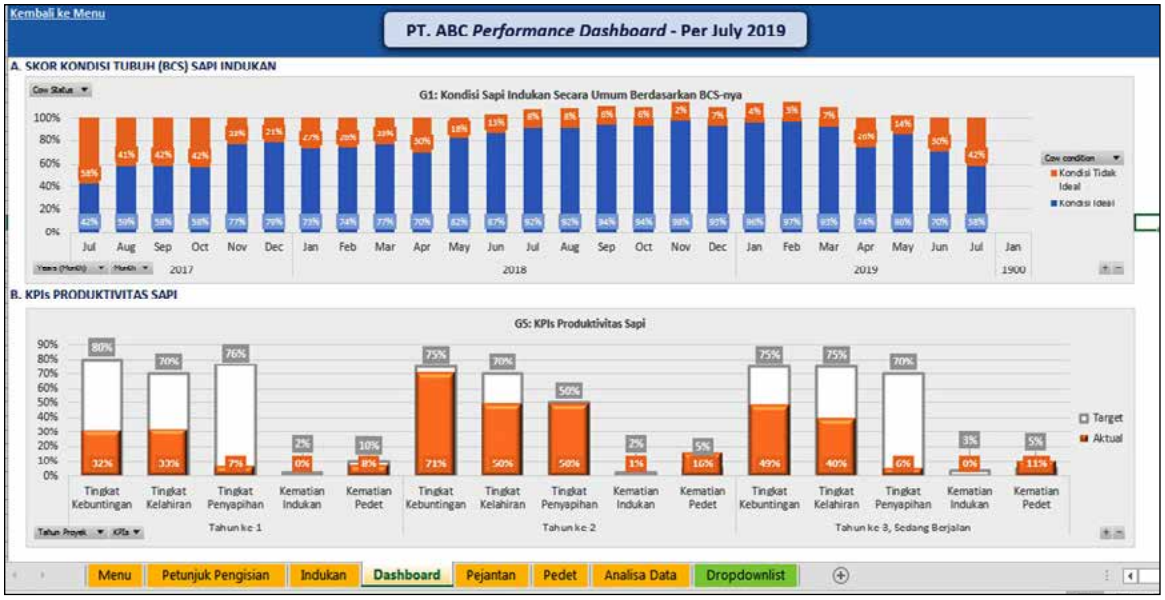
4.4.5. Monitoring spreadsheet and software

IACCB has developed two other tools to support Indonesian cattle breeding investors.

CALPROS spreadsheet

CALPROS: Cow-calf Operations Productivity Spreadsheet is for monitoring the productivity of breeders and their progeny. Based on Microsoft Excel, it can be used by new actors in the cattle breeding industry to monitor their operations.

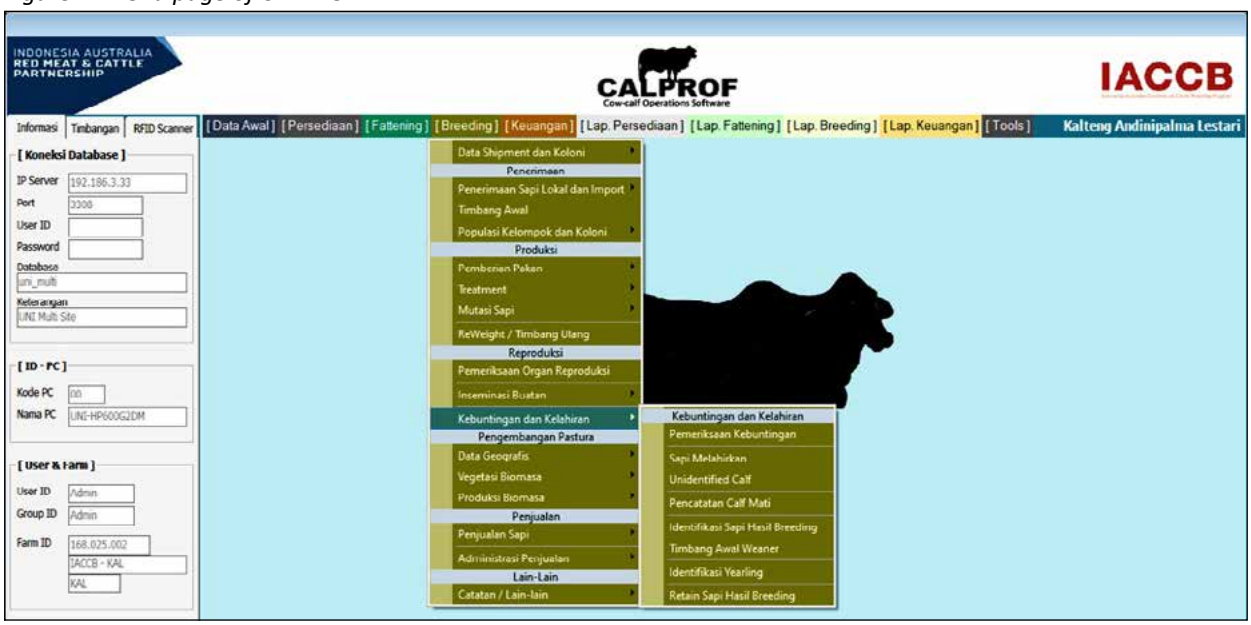
Figure 1. Example of output from CALPROS



CALPROF software

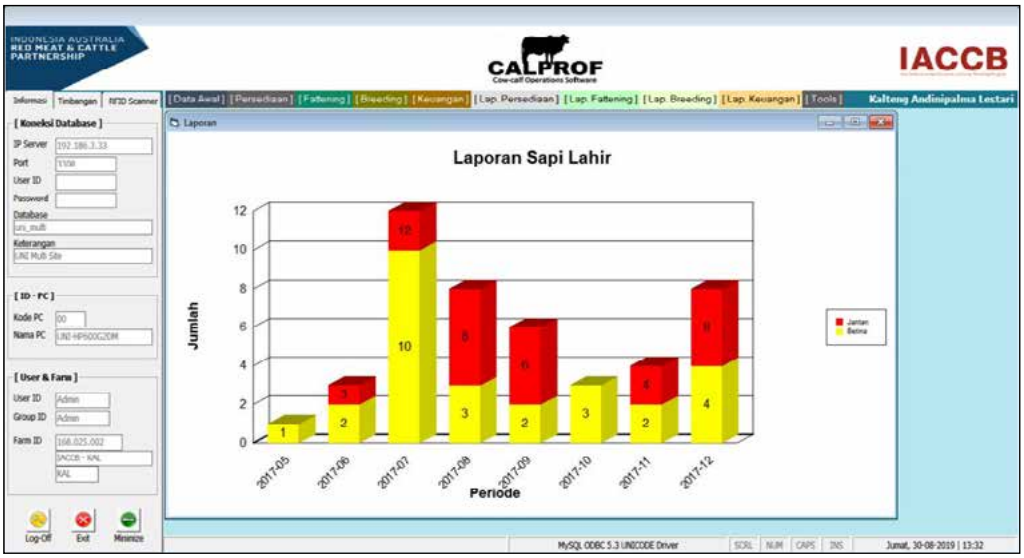
CALPROF: Cow-calf Operations Software, produced in collaboration with a local software developer, enables a company to track progress and profitability, and generates a record of key performance indicators.

Figure 2. Menu page of CALPROF



4.4. Enterprise costs

Figure 3. Example of output from CALPROF



Monitoring spreadsheet and software

The IACCB has developed a range of monitoring and evaluation forms for its own use. The forms are broadly applicable to most cattle breeding enterprise and can be amended as required to suit specific requirements (available *online*). Topics covered by the forms are listed below.

Form 1. Block, paddock, yard and pen profile
- Form 1.1. Block / paddock profile
- Form 1.2. Breedlot pen profile
- Form 1.3. Group / mob profile

Form 2. Pasture development
- Form 2.1. Pasture development in paddock / block

Form 3. Cattle herd information
- Form 3.1. List of mobs and specifics
- Form 3.2. Mob movements to blocks / paddocks
- Form 3.2. Individual cattle movements

Form 4: Body condition score (BCS)
- Form 4.1. BCS for mob / group
- Form 4.2. BCS for individual cattle

Form 5: Cattle feeding
- Form 5.1. Daily journal of feeding in pens / breedlot
- Form 5.2. Daily journal of feeding in grazing areas
- Form 5.3. Daily journal of stock feeds

Form 6: Cattle weights
- Form 6.1. Individual liveweights
- Form 6.2. Mob liveweights

Form 7: Animal health
- Form 7.1. Vaccinations
- Form 7.2. List of sick, culled and dead cattle
- Form 7.3. Supplies of veterinary medicines

Form 8: Reproduction
- Form 8.1 Natural mating
- Form 8.2. Artificial insemination

Form 9. Pregnancy testing

Form 10. Calving and weaning

Form 11. Business expenditure
- Form 11.1. Service providers and supplier names
- Form 11.2. Purchase of feed and other products
- Form 11.3. Expenditure of other business

Form 12. Business income
- Form 12.1. Cattle sales
- Form 12.2. Other business income

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